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ON THE COVER

This 6-centimeter-high Mexican smithsonite and hemimorphite specimen from the Martin Zinn collection was shot by noted mineral photographer Jeff Scovil. See more of Jeff's outstanding photos inside.

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Focusing On Minerals

Jeff Scovil Shares His Photography Secrets

Story by Steve Voynick / Photos by Jeff Scovil

WAYNE THOMPSON MINERALS

Scovil used putty to secure and support this elbaite on albite from the Tourmaline Queen Mine.

Of all the new, large-format mineral books that are filled with wonderful photographs, *Masterpieces of the Mineral World: Treasures from the Houston Museum of Natural Science* (Abrahms, 2004) is among the finest. *Masterpieces* showcases 150 spectacular specimens from the Houston Museum of Natural Science mineral collection, widely considered one of the world's best. When curator Joel A. Bartsch and his distinguished co-authors Wendell E. Wilson and Mark Mauthner sought photographs that would capture both the mineralogical perfection and the artistic essence of these outstanding specimens, their choice of a primary photographer, to no one's surprise, was Jeffrey A. Scovil.

GENE AND ROZ MEERAN

A neutral gray background sets off this brilliant 23 carat tanzanite gem without detracting from it.

BILL LARSEN

A tightly focused spotlight gives life to the dark background behind these Ukranian beryl specimens.

Scovil's name is well known to almost everyone interested in minerals or mineral collecting. Over the past 15 years, some 10,000 of his mineral photographs have appeared in books, catalogs, postcards, calendars, posters, and on the covers and pages of mineral-collecting magazines worldwide, including those of *Rock & Gem*. But while countless thousands have admired his superb photographs, not everyone is familiar with Scovil himself, how he became a mineral photographer, and how his profession has evolved into a highly specialized field.

Scovil's development as a mineral photographer began, logically enough, with youthful interests in both minerals and photography. When Scovil, who was born in Denver but raised in Westport, Connecticut, graduated from high school, his father gave him his first camera and taught him the basics of photography. As a former petroleum geologist, his father also instilled in him an interest in minerals.

Scovil attended Southern Connecticut State College (now Southern Connecticut State University), where his fascination with minerals first led him to major in geology. But broader interests soon steered him toward courses in archaeology and anthropology. When Jeff graduated in 1977, it was with a bachelor's degree in sociology.

HELIODOR MINERALS

Scovil selected a green background to complement the reddish-purple color of Namibian copper.

WAYNE THOMPSON MINERALS

A halo, created by a spotlight, breaks up background monotony and provides compositional balance to this photo of Pakistan aquamarine.

He then moved to Arizona for graduate work in archaeology at Arizona State University, where he began putting his photographic talent to practical use. Scovil had always enjoyed photographing small objects such as butterflies and mineral specimens. He applied this interest to laboratory photography, shooting artifacts recovered from the Salmon Ruin archaeological site near Farmington, New Mexico, where he would work for seven summers.

"I was also very interested in minerals and envisioned building a significant collection, but my limited resources made that an unrealistic goal," Scovil recalls. "Realizing that I was unlikely to make my mark on the mineral world as a collector, I thought about becoming a mineral photographer and began seriously studying examples of mineral photography."

KEITH AND MAUNA PROCTOR

A neutral, dark background contrasts with the red and white of this Sweet Home Mine rhodochrisite and needle quartz.

During the 1970s, Scovil's photographic aspirations had coincided with a turning point in the evolution of mineral photography. Previously, mineral photography had been limited largely to creating objective images of specimens, photographs that accurately, if somewhat unimaginatively, recorded such features as color, texture and morphology, an approach that certainly sufficed, especially from the mineralogical standpoint.

Mineral photography had already begun changing in the late 1960s, when photographers and collectors started to perceive fine specimens not only as mineralogical examples, but also as bona fide objects of art. At the same time, the rapid growth of mineral collecting was expanding the market for related publications. Making their appearance were books featuring large, color photographs of fine mineral specimens, such as Smithsonian curator Paul Desautels' 1968 classic *The Mineral Kingdom*. Also being introduced were new collecting periodicals such as *The Mineralogical Record* (1970) and *Rock & Gem* (1971).

Among the pioneers of modern mineral photography was Lee Boltin, an accomplished museum photographer noted for his dramatic and creative images of art and artifacts. Boltin's eye-catching, artistic interpretations of mineral specimens had been featured in Desautels' *The Mineral Kingdom*.

"Boltin's photographs really impressed me," Scovil remembers. "I thought they were the best mineral photographs ever taken at that time. I also admired the work of photographers like Wendell Wilson and Harold and Erica Van Pelt. I analyzed their photographs to figure out how they used lighting, lenses, glass shooting platforms, and backgrounds to achieve that added dimension of artistic expression."

Although Scovil had never taken a photography course, he began through trial and error to devise photographic techniques that enabled him to replicate the photographs he had studied, and sometimes to even improve upon them. In 1983, his first published mineral photographs appeared in *The Mineralogical Record*.

But Scovil's mineral photography remained a part-time pursuit through the 1980s. Still a graduate student, he made ends meet by operating a custom woodworking shop and later managed a finishing lab, doing portrait touch-up work. Finally, in 1990, he took a big gamble and became a full-time, professional mineral photographer.

"I had no real reason for turning pro," Scovil admits, only half-jokingly. "To this day, I don't know if the move, at the time, was smart, brave, or just plain dumb. But I was slowly starving and thought that I may as well starve doing something I liked."

Despite his uncertainties, by turning pro, Scovil opened a new sector in the mineral-photography market. Back then, the few professional mineral photographers did only high-end work for museums, publishers, and top collectors, charging rates that average collectors couldn't afford. But Scovil's very reasonable rates attracted a clientele of local collectors and dealers who couldn't afford the established photographers.

continued on next page

Focusing on Minerals *from page 13*

"I did strictly local shooting for a year, until *Rocks & Minerals* asked me to travel to Southern California to shoot some specimens from a top private collection," Scovil recalls. "When I picked up additional work on that trip from another California collector, I realized that local shooting wasn't enough, and that I needed the exposure that would come only with more traveling and attending shows."

Scovil initially worked only in 35mm. But in 1992, he discussed his professional future with show producer Marty Zinn, who didn't think 35mm would allow him to compete with the top mineral photographers. Magazine-cover photography required the 4x5-inch format, but Scovil didn't have the money to invest in new equipment.

Zinn offered to loan Scovil $2,500 for one year. For the "interest" on the loan, Scovil would shoot some 4x5-inch transparencies for Zinn. A year later, Scovil repaid both the principal and the interest.

"That was a turning point in my career," Scovil notes. "With 4x5-inch equipment, I could compete with anybody."

Today, Scovil is a member of a very small group of world-class mineral photographers. Much of his success is due to his distinctive style. His photographic images are characterized by a luminous quality that, combined with technical precision and creative backgrounds, produces a very appealing, almost mesmerizing three-dimensional effect. And from his careful presentation of the specimens in his photographs, it's clear that Scovil knows minerals as well as he knows cameras.

"Successful professional mineral photography requires a distinctive and recognizable style," Scovil explains. "And to develop a style, a photographer needs two things. First is technical competence in the art of photography; in other words, mastery of the hands-on aspects of lenses, lighting, setups, and so forth.

"Second is a love for, and an understanding and appreciation of, minerals themselves," he continues. "A good mineral photographer realizes that every mineral specimen is unique, with its own particular colors, size, texture, form, and even degrees of rarity and perfection. And being able to sense the special essence of a particular specimen is the key to knowing how it should be photographed. A good photographer also understands how a collector or a curator might view a specimen—which is often different from the way a mineralogist would view it."

STEVE SMALES

A blue background provides contrast to the lighter-colored crystals of powellite and scolecite.

So how does Scovil assess a specimen for photographic purposes?

"Holding the specimen in my hands, I rotate it slowly and study it from all sides," he explains. "In most, but not all, specimens, one angle is best. When photographing multifaced crystals, that angle can be critical. When shooting crystals, I prefer to show as many faces as possible—without unduly compromising the ideal viewing angle."

Scovil next determines how to support the specimen. Most minerals are photographed on nonreflective glass, which gives the photographic illusion that the specimen is floating on air. Specimens are often propped up with putty that must be completely hidden from the camera. *Securely* supporting the specimen is a must. No one, as Scovil points out, wants to see a $10,000 specimen fall and shatter.

JEFF COLLINS

This specimen of Colombian pyrite was photographed on a shooting platform of nonreflective glass.

Background is another very important consideration. A properly colored and lighted background can both "present" a specimen and enhance the perception of its colors. Scovil's background colors are usually complementary to, and contrasting with, the specimen colors. He avoids yellow, orange, and garish, bright hues of other colors that distract from the specimens themselves.

Finally, Scovil arranges his lighting, a critical aspect of mineral photography that requires great skill. In most setups, Scovil simultaneously uses two separate lighting arrangements: one for specimen illumination, the other to create desired background effects.

Proper lighting of mineral specimens, especially those with multiple crystals, can be tedious because of the profusion of angles among the many crystal faces, any one of which can create a specular reflection and an unwanted mirrorlike glare of light. The entire specimen must be lighted in a way that eliminates all specular reflections. Lighting becomes further complicated when transparent or translucent specimens require backlighting.

Background lighting is no less important that specimen lighting. Scovil considers evenly lighted backgrounds to be monotonous and unattractive. To avoid that, he uses tightly focused spotlights to create bright areas that he calls "halos," which he carefully places to highlight part of a specimen or even to conceal reflections in the glass base.

Scovil combines shooting with a tight schedule of shows, lectures and travel. Among the dozen shows he attends and shoots at each year are those at Tucson, Arizona; Cincinnati; Rochester, New York (the Rochester Symposium); Springfield, Massachusetts; Costa Mesa and Pasadena, California; Ste. Marie-aux-Mines, France; and Munich, Germany.

"Shows give collectors and dealers the opportunity to have their specimens photographed right there," Scovil says. "For shows that I can drive to, I'll take along as many as 600 pounds of cameras, lights, props, and backgrounds—enough to handle anything that comes up. But when I fly to shows, I take much less gear and improvise when I get there."

Several years ago, Scovil flew to Moscow to shoot Fabergé creations at the Fersmann Mineral Museum. He traveled "light," assuming he could easily obtain nonreflective glass for a shooting platform.

continued on page 16

"But the only glass Moscow seemed to have was scratched beyond belief," he recalls. "I ended up using the unscratched glass from the sliding door of a cabinet to complete the assignment."

Scovil also presents about 10 lectures each year. His most popular topics include how-to information about mineral photography and his travel experiences, the most recent of which was a 2004 trip to mine sites in China's Hunan Province as the guest of a prominent Chinese mineral dealer. All his lectures, as one would expect, are well illustrated with his own photographs.

As any photographer knows, no assignment is really completed until the film has been processed. After one long trip to shoot assignments in North Carolina and in Russia, Scovil returned home and sent the film for processing. But the developing lab called a short time later with bad news: An "accident" had ruined 10 rolls of film.

"That was really discouraging," Scovil admits. "I re-photographed some of the specimens a year later, but I was never able to re-shoot the rest."

Over the years, Scovil has also found that certain minerals or mineral objects are inherently difficult to photograph.

"Spheres are the worst," he says. "Because of their shape and polished surface, they reflect everything. And they can be transparent, translucent or opaque, or even have inclusions that must be brought out in the photograph. I have five separate lighting arrangements for spheres only. But shooting spheres is a lot like mineral photography in general—you learn as you go, and you always look for ways to do things a little better."

Some collectors bring their prize specimens to shows for Scovil to shoot, while others ship them to his Phoenix studio. Either way, more collectors and dealers than ever are having their prize specimens photographed.

"Many collectors who acquire fine specimens are looking for a little recognition," Scovil explains. "And the best way to get a photograph published is to send the editors one of professional quality.

"Also, a professional photograph both creates a record of a specimen and establishes it in the sense that it becomes more desirable and collectible," he adds. "And that directly impacts specimen value. As an example, I've had dealers bring me beautiful specimens to photograph, and when I returned them along with my photographs, they immediately increased the prices of those specimens."

When Scovil started out as a professional mineral photographer, he had to sell himself to potential clients. Today, clients come to him. As an example, the authors and publisher of the superb *Minerals of Nevada* (University of Nevada Press, 2004) asked Scovil to be their primary photographer. That happened again with *Masterpieces of the Mineral World: Treasures from the Houston Museum of Natural Science.*

"I'm particularly proud of the Houston Museum book," says Scovil, whose photograph of a spectacular, crystallized gold specimen from California adorns the cover. "That assignment required four trips to Houston and two weeks of shooting, all of it on 4x5-inch film. The museum wanted a very specific effect that I achieved with a neutral black-grading-to-gray background. I used that background exclusively throughout the book."

CINDY RZONCA PHOTO

Master mineral photographer Jeff Scovil works out of his Phoenix, Arizona, studio.

Among Scovil's most recent honors is his inclusion in "The Grandmasters of Mineral Photography," a special issue of the Moscow-published *Mineralogical Almanac,* which presented its choices for the world's top 14 mineral photographers. Scovil is recognized along with four other noted American mineral photographers: Terry Huizing, Harold and Erica Van Pelt, and Wendell Wilson.

Although best known as a mineral photographer, Scovil is also a writer. His first article, "Mineral Photography: Basics and a Different Approach," appeared in *Rocks & Minerals* in 1984. His most recent article, "A Mineral Excursion to China: 2004," which included 25 of his photographs, also appeared in *Rocks & Minerals.* But his best-known writing effort is *Photographing Minerals, Fossils, and Lapidary Materials,* a 224-page book with 200 of his photographs (Geoscience Press, 1996). Useful to both mineral collectors and amateur photographers, this popular book details the techniques behind Scovil's outstanding mineral photographs.

Because of the prestigious publications in which Scovil's work regularly appears, some smaller collectors wrongly think that his photographic services are unaffordable.

"That's not at all true," he points out. "As a professional, I started with small collectors, and I've never forgotten them or their needs. Collectors who inquire will be pleasantly surprised at my rates."

Scovil also sells prints, suitable for framing, of his many mineral photographs, as well as note cards illustrated with his photographs.

What does Scovil think of the future of mineral photography?

"Because there are only a certain number of ways to photograph a mineral specimen, I think we've reached the pinnacle of the art in that respect," he observes. "But digital photography and related software programs now provide the ability to 'clean up' and enhance digital images. So I think we'll see an improvement in the overall quality of mineral photographs. I also expect continued improvement in amateur mineral photography. Because of the high quality of today's professional photographs, amateurs now know good mineral photography when they see it and are emulating it."

And what are Scovil's thoughts about his own 15 years as a professional mineral photographer?

"It has been a wonderfully rich, multifaceted experience," he says. "I work with minerals and photography, the two things I love best. I meet wonderful people, study magnificent specimens from the best collections, and travel to fascinating places. Along with shooting, I also teach, lecture, and am continually exposed to new aspects of art and science. I think I have the greatest job on Earth."

For further information about Scovil and his mineral photography services, write to Jeffrey A. Scovil, P.O. Box 7773, Phoenix, AZ 85011, call (602) 254-0735, e-mail jeffscovil@earthlink.net, or visit the Web site www.scovilphoto.com. Scovil's book *Photographing Minerals, Fossils, and Lapidary Materials,* is available from the author or from Geoscience Press in Tucson, Arizona.

SHOP TALK

by William A. Kappele

Tumbling Tears

Most, if not all, of us are familiar with those little pellets of obsidian found throughout the Southwest and known as Apache tears. There is an age-old legend about how they came to be that goes something like this. Once upon a time, a band of Apaches was ambushed by an enemy tribe. Though they fought bravely, they were hopelessly outnumbered and were driven to the top of a high cliff. With their arrows gone, they were unable to fight. Too proud to be taken captive, they leapt from the cliff to the rocks far below. The Apache women were grief-stricken over the loss of their loved ones and shed torrents of tears. So great was their grief that the tears turned to obsidian.

Well, this is a nice story, but the tears shed by the poor Apaches pale in comparison to the tears shed by rockhounds who have been trying ever since to get a decent polish on these "tears of grief." One such rockhound is Mel Gascoyne, one of our neighbors to the north in Manitoba, Canada. Mel e-mailed me a while back to say that although he gets good rounding down to 600 mesh, the polish is disappointing, with a charcoal-colored sheen and tiny pock marks on the surface. I gave him all the information I had at the time, and I will give it here, plus quite a few more ideas that I have come across since.

The problem always seems to be in the polishing stage, so the tips will concentrate on that. The tips have been pulled from sites all over the Internet. Each one has probably worked for the writer, but you will see many direct conflicts. Remember that this is not an exact science, and what works for one may not work for another.

1. Do not use cerium oxide or tin oxide, since these are acidic and obsidian is alkaline. Don't use a vibratory tumbler, since it will cause the obsidian to spall badly. Use walnut shells or rice hulls rather than plastic pellets.

2. Slow the tumbling action as much as possible. Thicken the slurry with corn syrup or sugar in a ratio of two parts to one part of prepolish and polish. Try polishing dry with cerium oxide and oatmeal.

3. Use tin oxide with a buffer of sawdust, sugar or soap.

4. Use crushed walnut shells, like the kind sold for metal finishing or as bedding material for small animals.

5. Polish with tin oxide and a filler of plastic pellets or ceramic media. Burnish as a final step by running in a thick mixture of water and Tide detergent.

6. Use cerium oxide and cornmeal. Run dry for three days.

7. Use cerium oxide and oatmeal dry in a vibratory tumbler. Run for several weeks.

8. For buffer, cut up plastic canvas sheets from a craft store.

9. Try a double handful of rubber bands for buffer.

10. Always use a vibratory tumbler for the polish stage.

11. Run your tumbler as slowly as possible.

12. Never tumble tears with any other stone or with other obsidian.

13. Tumble mixed sizes together.

14. Don't tumble mixed sizes together.

15. Add white table sugar to the prepolish and polish stages. It is a mild abrasive and also thickens the slurry.

Have fun, and let me know what works for you.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

by Steve Voynick

A Nickel's Worth About Nickel

Of the approximately 165 minerals that contain the element nickel, most collectors are familiar only with pentlandite (an iron-nickel sulfide and the most common nickel-bearing mineral) and niccolite (also nickeline, a nickel arsenide). Pentlandite is brassy to bronze-yellow, while niccolite is a copper red; both minerals have a metallic luster and occur in massive form, rarely as crystals.

Pentlandite is the primary ore of nickel, a white, lustrous, relatively hard metal that is similar in many respects to iron. With an atomic weight of 58.69, nickel is as dense as iron and even shares some of its ferromagnetic properties. Like iron, nickel occurs as a native element only rarely, and then as tiny cubic crystals in nickel-bearing, altered ultramafic (iron-rich) rocks.

Within the Earth's total mass, nickel is the fifth most abundant element, behind iron, oxygen, silicon, and magnesium. Most of this nickel is found in Earth's core, which consists almost exclusively of iron and nickel. In the crust, nickel is much less common, ranking 22nd in abundance among the elements.

Although nickel often occurs with copper and has long been used in nickel-copper alloys, it was not recognized as an element until 1791, when Swedish chemist Axel Frederic Cronstedt chemically reduced niccolite to elemental nickel.

Nickel is classified as a siderophile, an element that readily associates with iron. The reason for this is that nickel's ionic radius matches that of iron. Because ions of the same size slip easily in and out of crystal lattices, nickel and iron can substitute for each other in iron-nickel minerals, in the Earth's iron-nickel core and even in the iron-nickel alloys kamacite and taenite that are found in iron meteorites.

But nickel does not share iron's susceptibility to atmospheric corrosion. While iron oxidizes (rusts) quickly, nickel is extremely corrosion-resistant. This property, along with its siderophilic characteristics, is the key to nickel's most important use as the primary alloying agent in the manufacture of austenitic stainless steels, steel alloys consisting of solid solutions of iron, nickel and chromium that form face-centered cubic crystals.

In austenitic stainless steels, chromium, which has a great affinity for oxygen, combines with atmospheric oxygen to form a micron-thick, inert surface layer of chromium oxide, which prevents further oxidation. The addition of nickel enhances this corrosion resistance and imparts high-temperature strength. As the most common type of stainless steel, austenitic alloys are used in everything from restaurant-kitchen equipment and tableware to the turbine blades of steam-powered generators.

Seventy percent of all nickel goes into austenitic stainless steels. Nickel is used as an alloying agent in specialized, exotic and "super" alloys; as a corrosion-resistant, electrolytic plating metal; and as a component of magnetic alloys, especially the powerful aluminum-nickel-cobalt "Alnico" magnets. Nickel is also used in rechargeable batteries, including mass-produced nickel-cadmium batteries, and in coinage metal. Because of its great affinity for hydrogen, nickel is an indispensable catalyst in the production of hydrogenated vegetable oils.

Nickel is mined from two types of ore deposits. Magmatic sulfide deposits, in which pentlandite is the principle mineral, provide most of the world's nickel. Less important are laterite deposits, in which the principal ore minerals are nickeliferous limonite, an iron-nickel hydroxide, and garnierite, a hydrous nickel silicate. Laterites are shallow deposits formed from the weathering of ultramafic rocks.

About 1 million metric tons of nickel are now mined worldwide each year. The leading producers are Russia, Australia, Canada, and Indonesia. The United States has no active nickel mines, but does recover small amounts of the metal as a byproduct of copper and palladium-platinum mining. Refined nickel metal currently costs about $2.75 per pound.

And, yes, nickels do indeed contain nickel. The United States' 5-cent coin is 25 percent nickel and 75 percent copper, an alloy not unlike that used in the coins of classical Greece 2,500 years ago. Several nations, notably Canada and the Netherlands, now issue coins that are 100 percent nickel—all of which is something to consider the next time you admire your prize specimen of pentlandite.

BRAD L. CROSS PHOTO

BRAZIL'S AMAZING AGATES

SHARON SMITH PHOTO

Brazilian agates most often contain earthy shades of brown, orange, blue, and gray, and suspended centers like this are fairly common.

BRAD L. CROSS PHOTO

After the bulldozer makes a pass, agate nodules are collected by hand from the host flood basalt.

Quantity and Quality Make It the World's Best Source

Story by Brad L. Cross

I grew up in south Texas in the early 1970s, and I was fortunate to have what was then the country's largest importer of Brazilian agate less than 100 miles from home. W.L. Cotton was a wildcatter, a Texas oilman in every sense of the word. The profits he made in the oil patch financed his gem and mineral business.

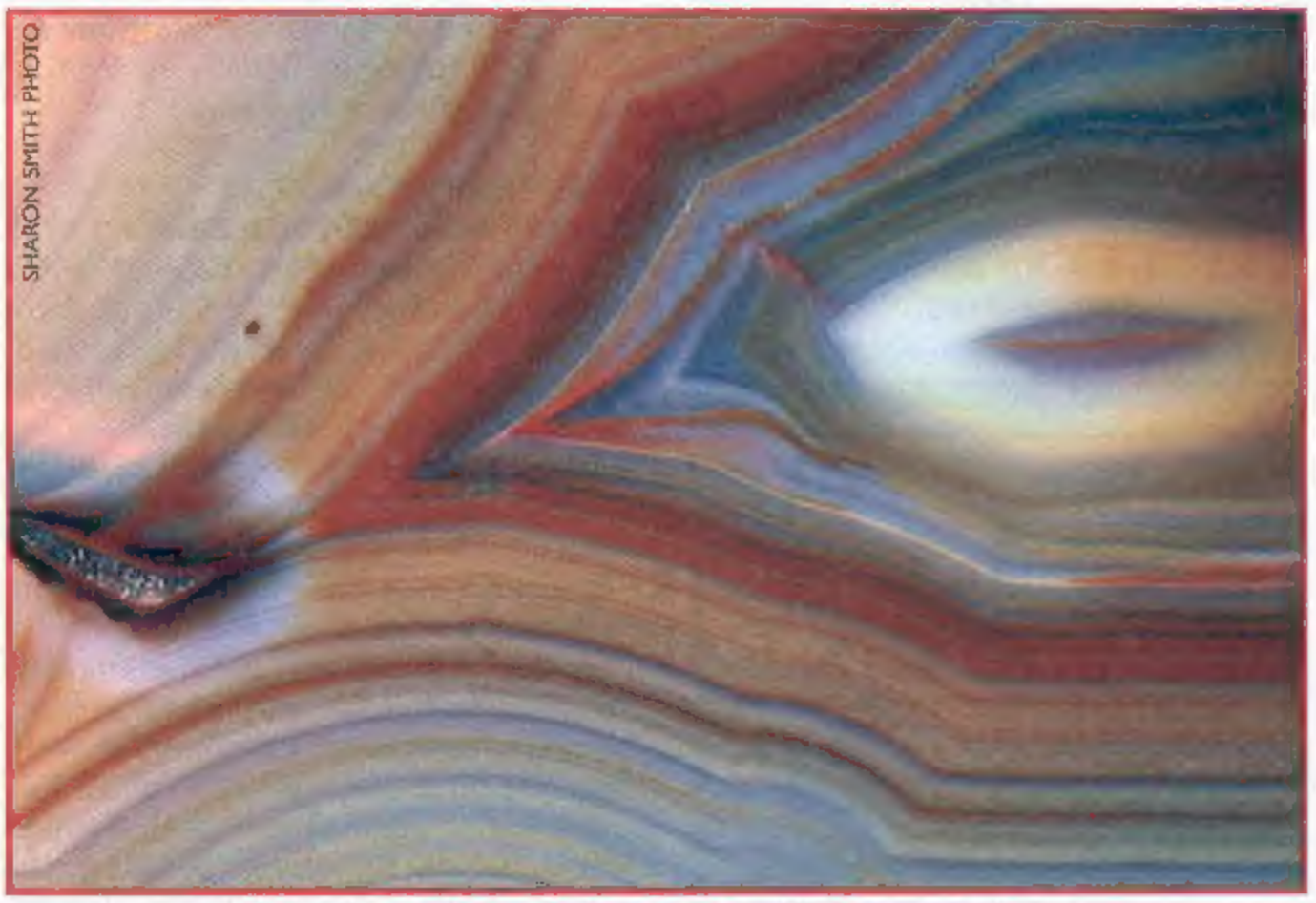
It was at his warehouse in the hot, dry, dusty town of Hebbronville that Cotton enticed me with colorful stories of his agate-buying trips to the far reaches of Brazil. We would then go outside to a large fenced area where mounds of Brazilian agate were stockpiled. Each pile represented a particular size or type of nodule and measured 6 to 8 feet wide, 8 to 10 feet long, and 4 to 6 feet high. Some individual agate nodules were over 3 feet in diameter. To me, they were literally mountains of agate.

I would spend every cent of what little money I had saved, but how could I go wrong buying banded agate for 35 cents per pound? The rear end of the car would sink to the ground as Mom and Dad loaded up this quarter's several hundred-

Brazilian agate shows a "bull's-eye" effect when it is cut across an internal tube or bubble.

Brazilian agate products are priced according to the quality of the agate and the number of square centimeters that required lapidary treatment.

pound purchase. All the way home, questions danced through my mind. How could anyone collect, process, and ship an agate that far for such little money? What were the agate fields like? How were the nodules mined? Being one who is never satisfied with just hearing or reading about an agate location, some years later, I set off for Brazil.



The variety of banding patterns in Brazilian agate is unlimited. There are swirls, folds, drapes, and inexplicable features.

HISTORY

The first commercial use of Brazil's vast agate deposits dates back to about 1830. It is told that a group of emigrant musicians from near Idar-Oberstein, Germany, discovered a wall made of agates. The agate mines back in the famous gem-cutting region of Germany could simply not meet demands, and a renewed supply of agate was badly needed. Brazil had a vast supply of readily available nodules.

In 1834, the first agates from Brazil were marketed in Idar-Oberstein. They were shipped from Brazil in rough leather bags and transported by sailing ships. The ships carried a wealth of freight from Europe to Brazil and almost nothing on their return trip, so the agate was indeed welcome ballast. When the ships reached Hamburg, the agate was reloaded onto smaller ships and sailed up the Rhein River to the town of Bingen. Then ox carts brought the freight to Idar-Oberstein. The three- to six-month journey (depending on the weather) brought agates that were sometimes more colorful, and certainly larger and more transparent, than the German agates. The Idar-Oberstein gem-cutting industry boomed again.

The agate was sold in a time-honored tradition that can still occasionally be found today, the agate auction. Agate shipments of 5,000 to 10,000 pounds would be split up into 50 or more individual lots. An official auctioneer ran the auction, and only cutters and gemstone dealers were allowed to bid. The highest valued agates were those that most readily accepted dyes. Chips would be taken from each lot and dyed, and the colored pieces displayed along with the rough.

GEOLOGY

The famous agates that have since flooded the market and yet remain as popular today as they were some 175 years ago are found in Brazil's southernmost state, Rio Grande do Sul. Geologic formations know no political boundaries, and the vast agate deposits also extend into Uruguay and other neighboring countries. The agates are found in the tholeiitic basalt flows of the Serra Geral Formation. Flood basalts are lava flows that arise from fissures and are spread laterally over a very large region. Some of the individual flows can be more than 150 feet thick! The old idea that these flows went whooshing over the countryside at incredible velocities (like a flash flood) have been replaced with the concept that the units are emplaced more like flows, slow-moving and filling preexisting valleys and depressions. A good example we might relate to is the Columbia River basalt province (15 million years old) covering most of southeast Washington State and extending all the way to the Pacific and into Oregon. This famous basalt flow also hosts a large volume of agates, thunder eggs, and jaspers.

continued on next page

SHARON SMITH PHOTO

All Brazilian agates occur as nodules and range in size from an inch to over 5 feet in diameter.

The Lower Cretaceous (about 100 million years old) flood basalts of southern Brazil are beyond extensive, covering an area of 463,000 square miles. While the basalts overlie the wind-blown Botucatu sandstones, the sandstone beds are also interlayered with the extensive basalt units. The upper half and the west side of Rio Grande do Sul are covered by basaltic rocks of the Parana Basin.

The agate-bearing zone is about 15 to 25 feet thick and is sandwiched between an underlying vesicular glass-rich dacite and an overlying vesicular rhyodacite, both of which may occasionally contain agates. The units have been highly weathered many times, and since the agates are resistant to weathering processes, they are left behind, many times completely filling local riverbeds.

TYPES OF AGATE

Although 99.9 percent of these South American agates are banded and in nodular form, many names have been given to the different varieties of agate found in Rio Grande do Sul. This has often been done for marketing purposes or for differentiating the uniqueness of one deposit from another. Some of the intriguing names heard over the years include Parana, Carazinho, White Skin, Rainbow, and Umbu.

Parana agate (sometimes misspelled as Piranha agate) does not come from the state of Rio Grande do Sul, but from near Guarapuava, in the state of Parana. This is a very colorful agate, with earthy shades of red, yellow and orange, and splashes of brown that many times cut across banding patterns. This agate is never dyed or heat-treated because the colors and fortification patterns are difficult to improve upon. I've rarely seen Parana as a complete, sealed nodule.

Carazinho agate is another beauty. This translucent to semitransparent agate often has color zones that run parallel with the banding pattern. This variety also needs no dyeing or heat treatment.

White Skin agate is a descriptive term that is applied to Brazilian agate that has been deeply weathered, creating a skin of white, clay sized particles. Although large concentrations may be found in isolated occurrences, white skins can be found at any given deposit in southern Brazil. The white skin can penetrate deeply into the agate, many times providing a nice color contrast to the blue-gray and even brown, red, yellow, or orange bands.

Umbu agate is a term used to describe the translucent blue gray agate from the Salto do Jacui area. Umbu is the form of agate most suitable for dyeing.

THE REGION AND THE AGATE MINING PROCESS

One of the richest agate deposits in Rio Grande do Sul occurs in the Salto do Jacui region. It's an area that is easy to find. Search a map of Rio Grande do Sul for a large lake more or less in the middle of the state. The city of Salto do Jacui is just south of the lake. This lake was created for hydroelectric power and has created some significant issues for the agate mining industry, as we shall see later.

A dense subtropical forest covers most of the gently rolling hills in the region, making mining somewhat difficult. Other areas in the agate-producing region are flat pampas grasslands. Temperatures in the humid summer reach 105 degrees F, and in the winter, nighttime temperatures easily reach freezing. The forested region is lush, and exotic birds of all types serenade you while you search for agate.

When the miner isn't the landowner, a lease is usually negotiated with the owner, who usually receives 15 to 20 percent of the production yield. However, there are many farmers in the Jacui area who actually mine the agate themselves and have significantly improved their incomes due to the agate deposits.

Such was the case at one agate mine I visited. Part of my time was spent at the Otto Muller farm along the Jacui River, where I had the opportunity to experience the complete agate cycle, from discovery of a new deposit to final processing of the treasures. Few words can adequately describe the thrill of walking along the forest floor and being the first to discover an outcrop of agate nodules against a backdrop of exotic ferns, lichen, and colorful mushrooms.

This area of the hill would soon be terraced in an attempt to recover the seam of nodules that appeared to intermittently snake through the formation. Unlike many agate deposits I've visited, the agates tend not to consistently blanket a specific area. Envision the occurrences much like large twisting snakes, winding in and out of the rolling hills and making it very difficult to construct adits and shafts.

Initially, a 250-foot test line is dug to determine the strike of the deposit. Passes are then made with bulldozers, and hired help walks behind the equipment, collecting nodules of all sizes out of the highly weathered basalt. As 5-gallon buckets are filled, they are placed in the back of a pickup truck and are then taken to the nearby farmhouse to be stockpiled and later processed.

Production amounts vary significantly. Any given mine may produce anywhere from several thousand pounds up to 500,000 pounds per month. While a large amount of the production remains in Brazil for processing, the largest bulk is exported to Asia.

The large, open-faced agate mining activities have aroused troubles with the state environmental agencies. Evidently, runoff from the mines has caused accelerated sedimentation issues and affected lakes created for hydroelectric power. Strict rules and regulations, complemented by enforcement actions, have affected mining operations throughout the agate-producing region.

With each pass of the bulldozer, I anxiously waited for it to uncover something new. Within 30 minutes, I had collected far more nodules than I could have ever transported home. My local friends took several fist-size agates from my hands, and by the end of my journey, they had cut and polished several collector-grade ennyaros from my find.

Enjoying a meal at the *churrascaria*, I visited with a local farmer who was rumored to have a basement full of rough agate stored for his grandchildren. He confided in me that as the better deposits are exhausted, remaining mines produce smaller agates of lesser quality. Even I couldn't argue that although present supplies in warehouses and at the mines seem inexhaustible, there will be a time not too many years away when fine-quality agate will become a rarity and choice stones will command substantially higher prices.

AGATE QUALITY

Brazilian agates are remarkable for their large size and lack of fractures. There are also no other agate deposits in the world that can compete with Brazil when it comes to quantity of agate

mined. Not only are tons of material mined and processed, the agates from southern Brazil come in all sizes imaginable, from pea size up to 3 and 4 feet in diameter. The agates that are too small to process or of inferior quality are usually crushed and used as road ballast. You can imagine my surprise when I drove into a quiet rural town of 50 or so residents and found the streets paved with agate. I had to pinch myself to be sure I hadn't died and gone to agate heaven.

Enhydros are stored in barrels of water prior to shipment so that their internal water is not lost before reaching the buyer.

Quality is a different story. For years, many of the banded nodules had wonderful, earthy shades of brown, red, orange, amber, black, yellow, pink, and blue. While these natural colors were not of the brightest shades known in the agate world, they were very attractive. Beautiful landscape scenes were also found in old, colorful pieces of agate. However, these naturally colored banded beauties are becoming more and more difficult to find.

Equally popular, even since the 1840s, are the dull blue-gray banded nodules. Their popularity is due primarily to their ability to readily accept dyes. Porosity varies from band to band in agates, giving each layer the ability to absorb a certain amount of color, or none at all.

THE DYEING PROCESS

The art of dyeing is nothing new; in fact, the art has been around for more than 2,000 years. Pliny's (23-79 A.D.) described the famous production of "black onyx" through artificial treatment. While susceptibility to dyeing is a very important criterion for determining the quality of rough material in the commercial cutting industry, agate collectors strongly object to this practice. It's important for the public to realize that the bright and shocking greens, blues, purples, and pinks commonly seen in polished agate specimens are not natural. Dyeing is fine as long as the seller informs the buyer that the colors are artificial. Dyed or heat treated agates should not be sold as natural formations.

I was able to observe the chemical treatment process while in Brazil. The coloring is not achieved by dipping the agate in a vat of dye, but by the causing various chemical reactions within the agate. In general, there are two methods of coloring a blue-gray agate. The first is to allow soluble metallic salts to soak into the pores of the agate. The salt is then changed to a colored oxide by heating. The second method involves two solutions, or baths, that are used in succession, the second bath causing a colored precipitate to be deposited within the agate.

No matter what color or method is chosen, the process always begins with thoroughly cleaning the agate to remove all grease and oil. The agates are generally boiled in a strong solution of sodium bicarbonate. Several rinses with water complete the cleaning.

For red colors, the agates are usually soaked in a strong solution of iron nitrate. The iron nitrate solution is kept warm and the agate is kept submerged for one to four weeks, depending upon the thickness of the agate. The stones are then oven baked for a number of days and acid soaked several times to form an iron oxide in the pores.

To obtain the bright green, several water-based dyeing solutions of chromic acid and ammonium carbonate are used. After soaking in each solution for a number of weeks, the agates are dried and strongly heated.

Black coloring was discovered by accident in 1819 by Idar-Oberstein cutters. Several liquids are used to create black agate, the first consisting of a thick (honey consistency) solution of sugar in water. The agates are soaked in this heated solution for several weeks and then transferred without drying into concentrated sulfuric acid. After heating and then cooling, the agates are washed and dried. The concentrated sulfuric acid extracts water out of the sugar, leaving behind pure black carbon.

Potassium ferrocyanide and a warm, saturated solution of ferrous sulfate are used to produce a Prussian blue or Berlin blue. The blue color develops over a period of several weeks.

The art of dyeing agates is just that—an art. The chemical treatments have been perfected through the years and precise

continued on page 98

LAPIDARY LORE AND MORE

by June Culp Zeitner

The Lure of Jade

The search for jade took Albert and me to several states and led us to find our most unusual specimen.

It was in the 1940s that Al and I were drawn to Wyoming by the lure of jade. We went in an International pickup. In the back were our Estwing hammers, "newspaper boy" bags, water, and lunch. It had been a cold winter, so we were anxious to get out in the mountains and do some serious hunting. We headed for the Green Mountains convinced that the word *green* hinted at jade.

Wyoming is the top producer of nephrite in America, with the possible exception of Alaska. Nephrite is one of two minerals called *jade*. The other, called jadeite, is scarcer, more colorful, and more expensive. If that makes nephrite less tempting, think of some of its good qualities. It is widespread, available in large pieces, and it is tough and resistant to heat. It takes and holds a good polish, and it is one of the top materials to carve. Also, it is well known and rich in history.

There were three variations to find: a piece of jade polished by the wind and sand, called a "slick"; a piece of jade with a quartz crystal in it or a pseudomorph of nephrite after quartz, and an attractive combination of pink thulite with spinach green jade.

We were granted permission to hunt on a huge ranch between two well-known localities. I had studied eight years of college art, so I was prepared to examine any green rock carefully. I had seen apple green, olive green, spinach green, beige green, and emerald green jade, and appreciated it all.

Huge masses of jade as large as 8,000 pounds were reported. We weren't prepared to deal with anything that big, but I thought we would find pieces maybe 50 to 100 pounds.

That figure was exaggerated. In the first place, there was the rough, sage-covered terrain. In the second place, the owner of the ranch who had given us permission to hunt came out to tell us we should disrobe periodically because Rock Mountain Spotted Fever was at an all-time high and his sheep carried the tick. After he left and we decided we were tick free, we were ready to concentrate on the jade.

Having been trained in the nuances of color in my art studies, I decided to look only for greens. I soon discovered that none of the rocks near me were green. There were large brownish-gray rocks and many small red-skinned boulders, as well as some white-skinned dark specimens.

It was mid-afternoon when we stopped for a cold drink from our stainless steel thermos. I had pounded on so many hard rocks I had a headache. I had only one keeper, an exceptionally dark rock with a red coating. I kept it for my sister May, who used attractive stones as bases for her gem trees.

Albert checked my finds, and when he came to the red skin, he said it was nephrite. He had a piece with a quartz crystal in it. Then he reached into his pocket for his prize, a lovely green jade slick. I told him there was a name for that kind of stone. It was German word, but I couldn't remember it.

We stopped at the home of nearby ranchers named Countryman. We heard they had a nice collection and sometimes sold specimens. They had jade all right, it looked like it could be a ton or more. We thought we'd buy a nice piece of apple green.

Mrs. Countryman said all they had on hand was already sold to two men from China who were due to stop for it the next day. We had sat down to visit over coffee when there was a knock at the door. It was two Chinese men. After a lot of bowing and formal greeting, they announced they had come to make arrangements for packing and shipping the jade and paying for it. We left with the knowledge that much Chinese jade came from Wyoming.

The Chinese were very liberal with their use of the word "jade." They called bowenite serpentine "new jade." They also referred to a bright-green aventurine as jade. (Green jasper was called jade in Mexico.)

An unusual jade found near Monterey, California, was botryoidal. It looks like a pile of small green apples. Some of this artistically shaped and textured jade was found offshore in the

Pacific. We were not successful in buying any at that time.

Our second Wyoming jade trip was successful. Bob Berry of Hoxie took us to a dam near Wheatland, where we found jade, agates, and petrified wood. Bob was puzzled by a find of Albert's. So was I. Al later polished it on our flat lap. I still have it, and I am still puzzled. It is 3 inches by 5 inches and is colored several pleasing shades of green, with a band of ecru, ochre and rust and a lacy top band of off-white. A cellular structure is apparent in all the colors, but more easily seen in the lightest color. Cells in jade? Or are they minuscule polka dots?

We visited Wisconsin once when nephrite was reported there. As reported, there were boulders along a fence row and country road. We didn't find any worth cutting though.

Another nephrite discovery has added to North Carolina's wealth of species. This, too, was not true gem quality.

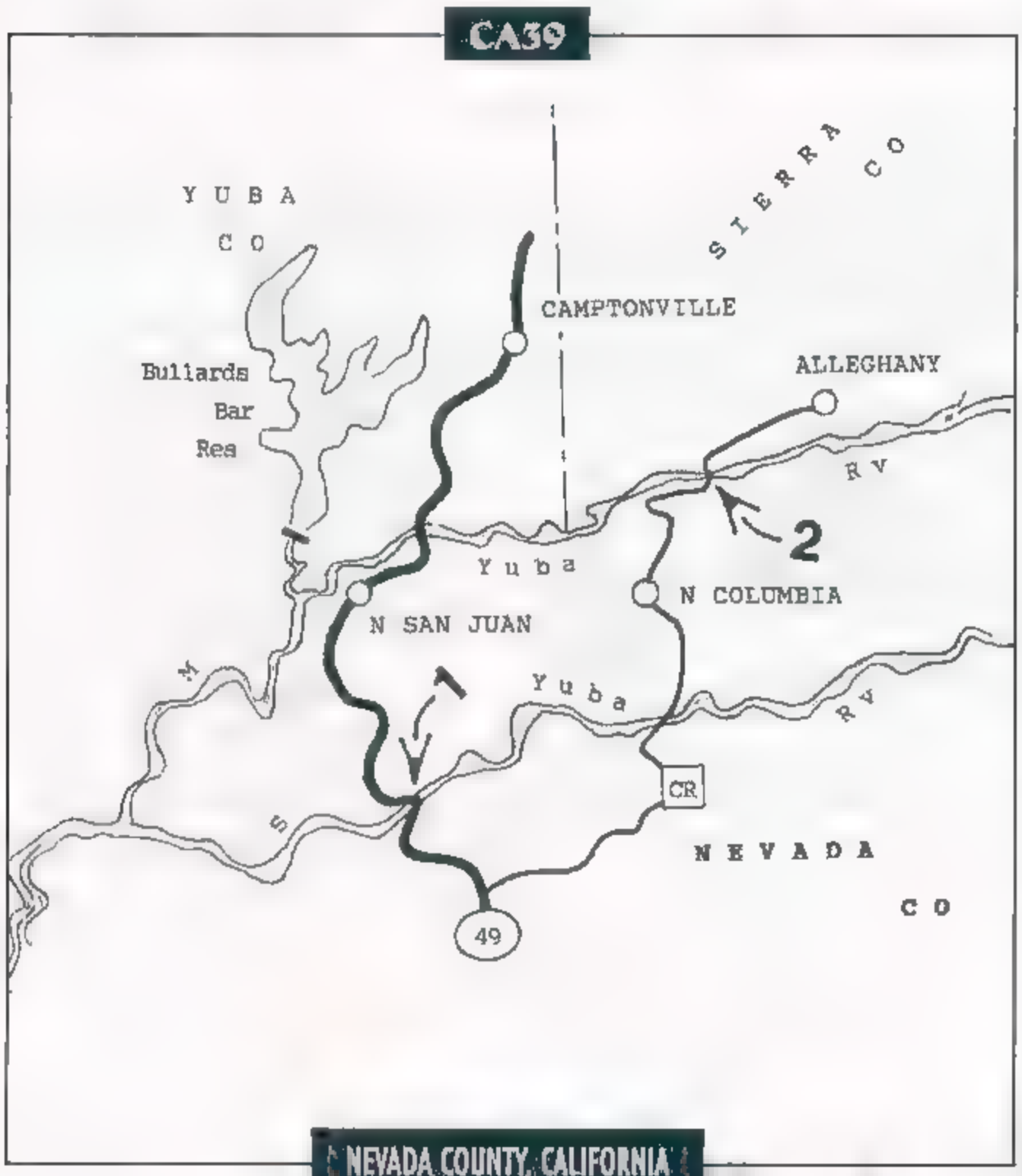
Botryoidal nephrite is found in several California localities, but these occurrences are rare. However, there is a large deposit of it in the Trinity Alps of Northern California. Another interesting California jade includes magnetite crystals. When gold-plated, only the crystals retain the gold, enhancing the near-black jade.

Alaska's Jade Mountain has produced tons of gem nephrite. My late friend Oro Stewart and her husband, Ivan, had a mine there and took huge boulders 30 miles down the Kobuk River to the sea. They sold the jade at their photo studio in Anchorage and decorated their lawn with it. The best find at their mine was chatoyant cat's eye nephrite. Cat's-eye jade is rare. When properly cut and polished, it is beautiful and pricey.

Needless to say, I accumulated quite a few jade specimens and items over the years. What is my favorite? Not the most beautiful or the biggest or the rarest color. It is the one that puzzles me most, the one with the cellular structure. Oh, yes, the word for the wind- and sand-polished slicks is *ventifact*.

ROADSIDE PANNING SITES IN CALIFORNIA

Part V: Nevada, Placer and Plumas Counties



NEVADA COUNTY (Maps CA39-41)

SITE 1. **South Yuba River/state Route 49** crossing near **North San Juan.** Vicinity finds include agate, chalcedony, gold, jasper, and silicified wood.

SITE 2. **Yuba River/County Road** crossing, near **North Columbia.** Vicinity finds indicate gold potential

Story and Maps by David and Clois Walker

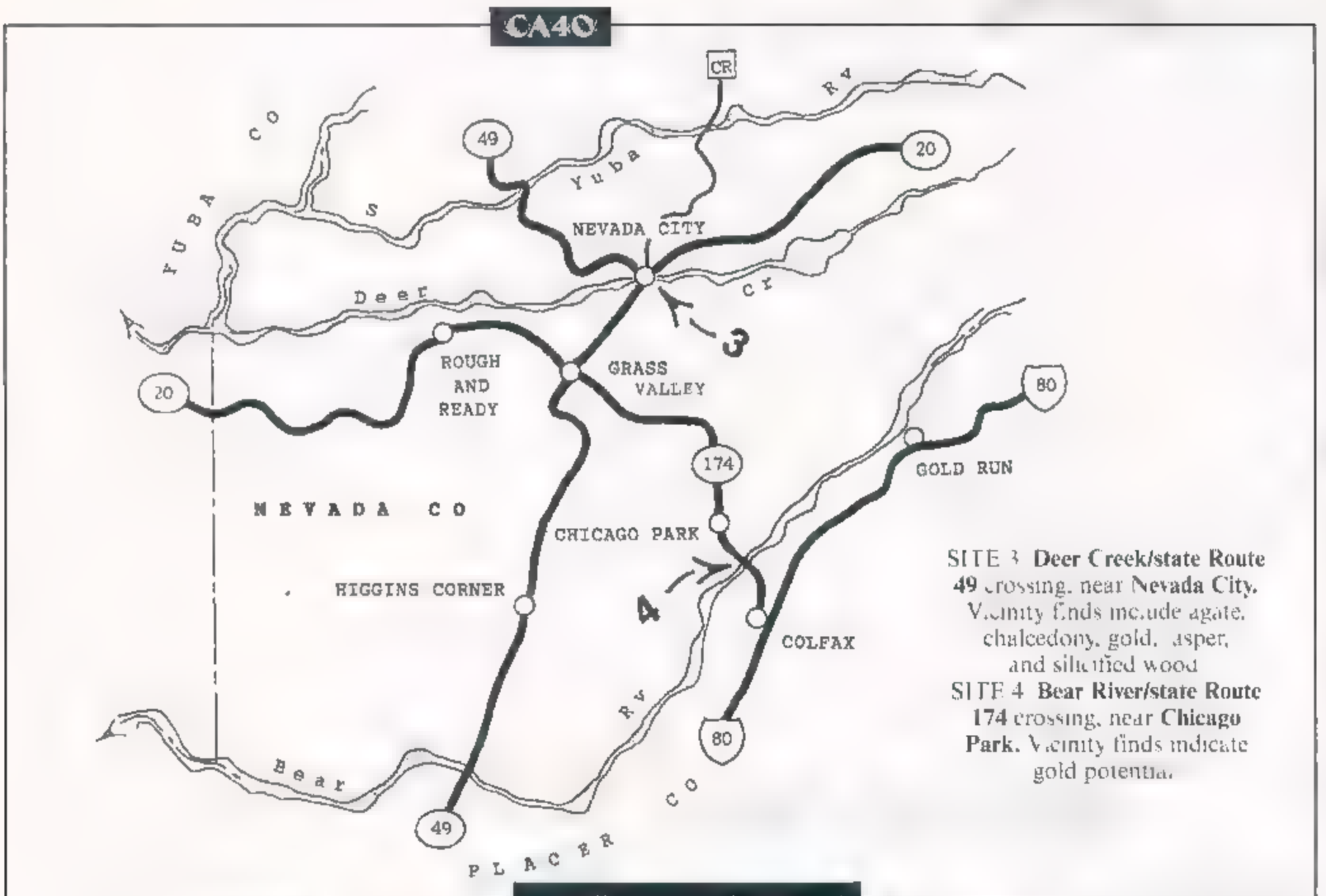
This is the fifth in a series of 10 articles containing county-by-county maps of suggested panning and screening sites at highway stream crossings where appreciable finds have been previously reported on upstream watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan.

Obviously a highway-convenience study of this kind is most advantageous for seniors and others who prefer panning under a nice, shaded bridge crossing to tramping over hill and dale. It also eliminates the necessity of locating and getting permission from property owners.

Don't forget, however, that the government to which these rights of way belong has some regulations of its own. Be sure to observe the usual safety and environmental standards if you want to collect without a hassle.

The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway map when planning an outing, for overall orientation in the field and because highway designations have been known to change.

So good luck! While we can't guarantee you'll hit the jackpot, we can almost assure an enjoyable outing.



SITE 3 **Deer Creek/state Route 49** crossing, near **Nevada City.** Vicinity finds include agate, chalcedony, gold, jasper, and silicified wood

SITE 4 **Bear River/state Route 174** crossing, near **Chicago Park.** Vicinity finds indicate gold potential

NEVADA COUNTY, CALIFORNIA

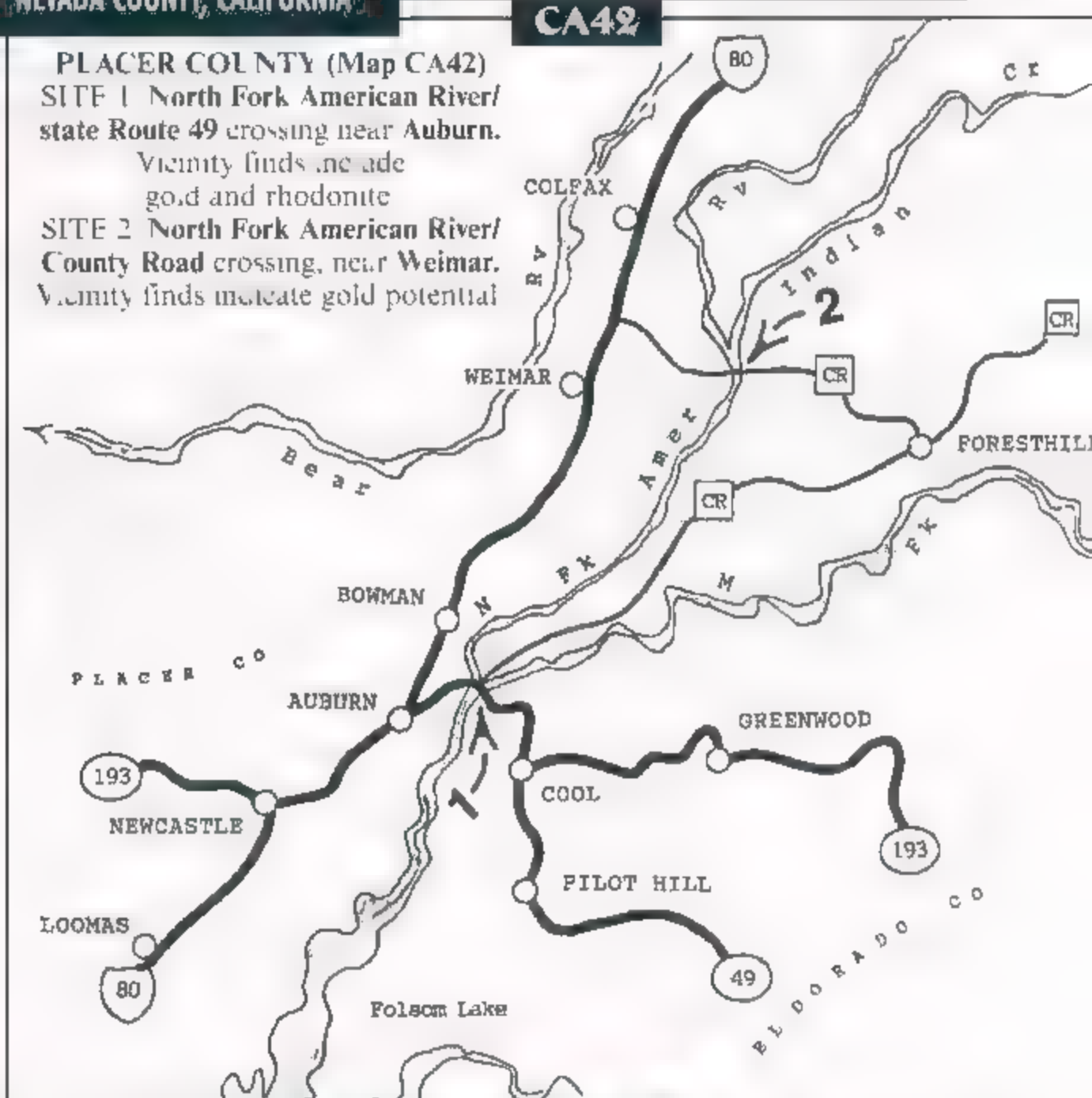
SITE 5 **Truckee River/state Route 267** crossing, near **Truckee.** Vicinity finds indicate gold potential

NEVADA COUNTY, CALIFORNIA

PLACER COUNTY (Map CA42)

SITE 1 **North Fork American River/ state Route 49** crossing near **Auburn.** Vicinity finds include gold and rhodonite

SITE 2 **North Fork American River/ County Road** crossing, near **Weimar.** Vicinity finds indicate gold potential



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PLACER COUNTY, CALIFORNIA

PLUMAS COUNTY (Maps CA43-46)
SITE 1 **North Fork Feather River/state Route 70** crossing near **Storrie.** Vicinity finds indicate gold potential.

SITE 2 **Wolf Creek/ U.S. Highway 89** crossing, near **Greenville.** Vicinity finds include gold and rhodonite
SITE 3 **Lights Creek/ County Road** crossing, near **Taylorsville.** Vicinity finds include gold and rhodonite

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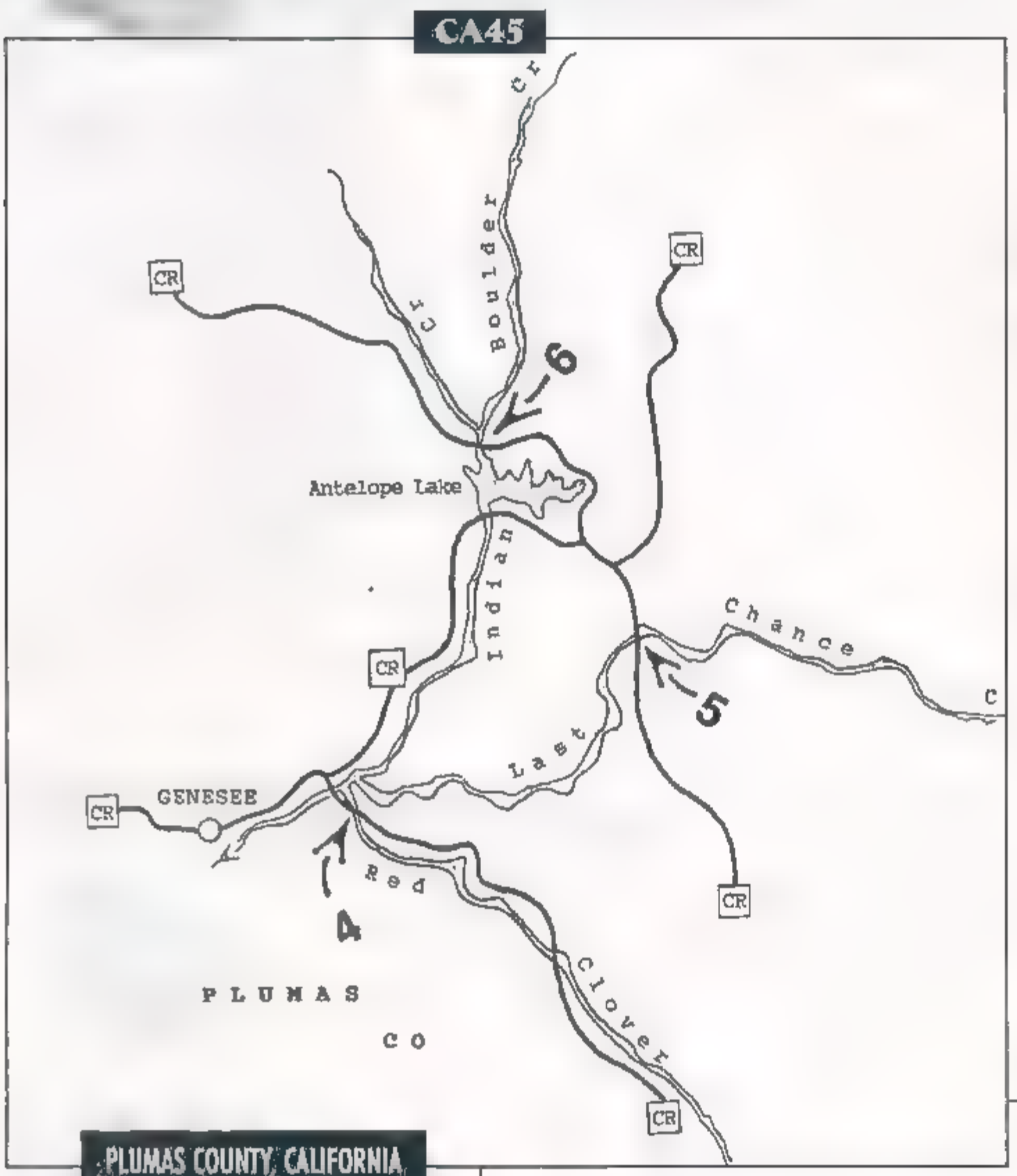


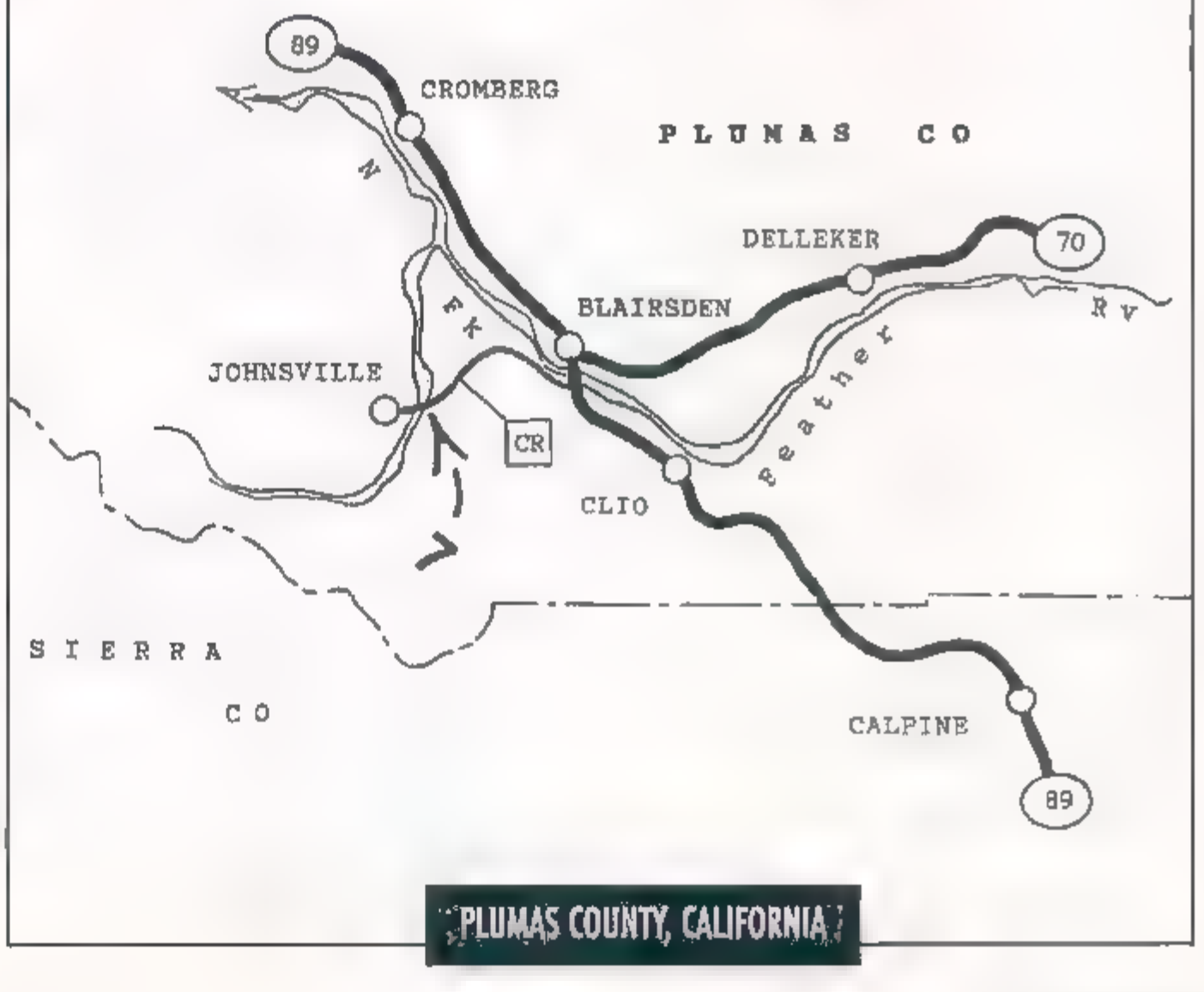
SITE 4 **Red Clover Creek/County Road** crossing, near **Genesee.** Vicinity finds include rhodonite and tourmaline.

SITE 5 **Last Chance Creek/County Road** crossing, near **Genesee.** Vicinity finds include gold, rhodonite and tourmaline.

SITE 6 **Indian Creek/County Road** crossing, near **Genesee.** Vicinity finds indicate tourmaline potential.

SITE 7 **Tributary North Fork Feather River/County Road** crossing, near **Johnsville.** Vicinity finds indicate gold potential.

The official state highway map is suggested in conjunction with these maps for overall orientation in the field.



The Tourmaline Group

PART I: Non-Gem Varieties Fit the Budget

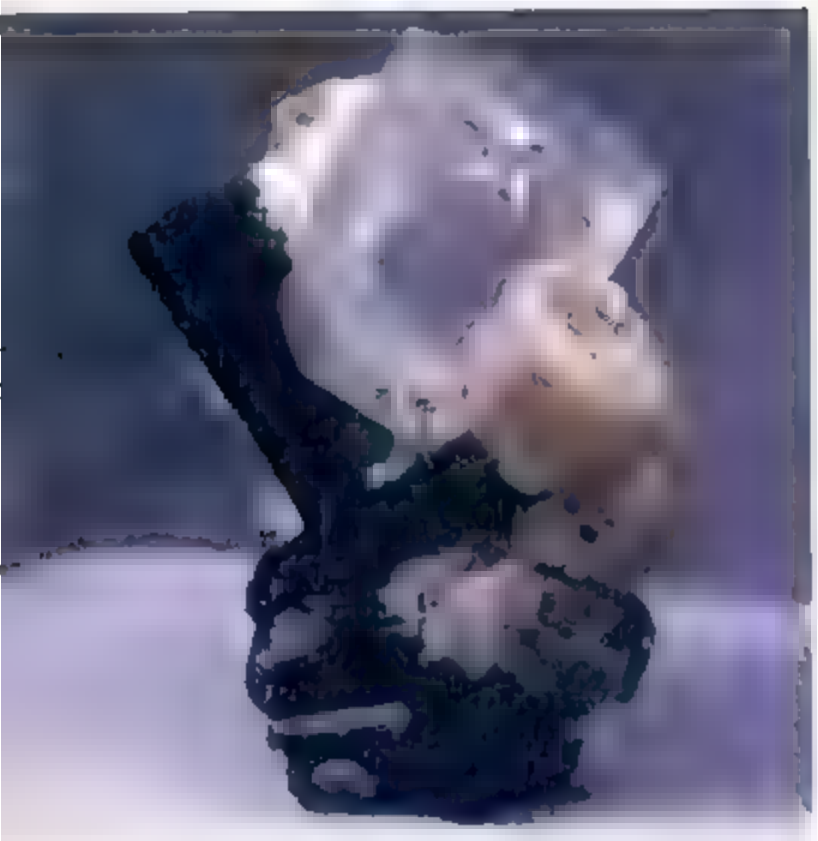
Story and Photos by Bob Jones

The delicate striations seen on this schorl are typical of most varieties in the tourmaline group.

Like garnet and feldspar, "tourmaline" is the name of a group of related minerals. The family consists of nearly a dozen different species, half of which are virtually unknown to collectors, while the other half ranks among the most popular collector minerals and gems. The popular half includes elbaite, liddicoatite, goshenite, schorl, dravite, uvite, and berguerite. These fine tourmalines occur often enough and in such attractive specimens that they are eagerly mined, collected and used.

Fortunately, some members of this group of six are within the reach of the majority of collectors. The popular non-gem members of the group — schorl, dravite, uvite and berguerite — sell for less, so the Frugal Collector should seek them out. The sharp-eyed Frugal Collector can sometimes also find small, attractive crystals of elbaite and goshenite, both on matrix and loose, at reasonable prices.

The other half of the tourmaline group are nonentities that collectors and readers probably have never heard of nor will ever see for sale, including the species fortite, feruvite and olenite.



This is a nice combination of black schorl and blue beryl aquamarine from Pakistan.

While identifying tourmalines is often pretty easy, the first finds of this abundant group were misidentified. That's understandable, since the first tourmalines were found as rounded pebbles in the gravels of Ceylon (now Sri Lanka) and showed no visible crystal form and none of the external striations we usually use to identify gemmy tourmalines. Other identifying properties like density and color can hardly be useful out in the collecting field. The color of these first rounded gem pebbles resembled zircon, so in 1703 they were called turamali (the name for zircon) and shipped to Europe for faceting. The species was later correctly identified, however, that original Sinhalese name stuck. This two part series will divide the more popular group of seven tourmalines into two subgroups. Part I will treat schorl, buergerite, uvite, and dravite. Part II will treat elbaite, goshenite and liddicoatite.

Uvite and dravite, usually a dark color and opaque, or nearly so, are sometimes found in gemmy crystals, but never abundantly. Still, they are very popular with specimen collectors, as they make excellent non-gem display specimens. They do not occur in pegmatites, but usually in metamorphosed limestones or other altered rock. Then there are two nice display non gem tourmalines that I refer to as minerals of the Dark Side, schorl and buergerite. Schorl can be brown to black and opaque. Buergerite is a lighter brown and common only from one locality.

When you begin to look at the chemistry of this group, you realize that more than a dozen elements can be found in tourmaline's structure. So, members of this group rank among the most chemically complex of all the minerals. Their complexity explains, in part, why they were not known as individual species until the 18th century.

Take uvite, for example. It has the shortest name of any group member, yet its chemical makeup boasts no fewer than 13 elements, including a couple of elements that repeat, like magnesium. For this reason, the tourmalines have been slighted by scientists.

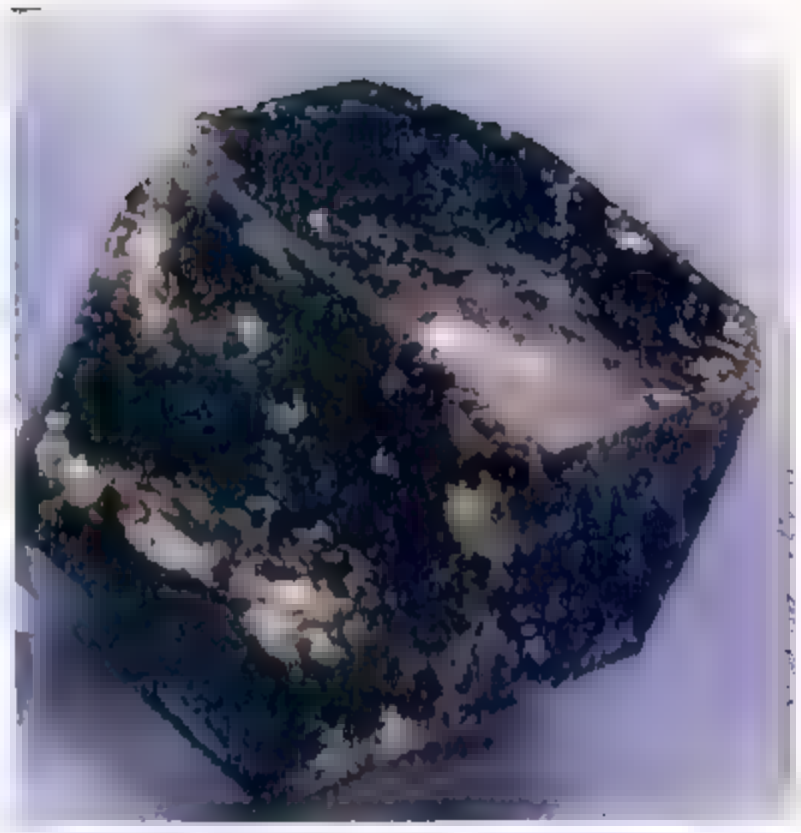
Tourmalines are trigonal borosilicates. This means the crystal form is generally hexagonal, though in gemmy crystals, especially elbaite and liddicoatite, it tends to be three-sided, with the three faces slightly curved. In spite of the variety of elements in tourmalines, boron is the one constant metallic constituent in each species within the group.

There are general characteristics that fit every member of the group to some extent. For example, many tourmaline crystals appear to be hemimorphic, meaning the two ends of the crystal have different forms. Internally, they are all hemimorphic to some degree. The opposite ends of completely developed quartz crystals, for example, look exactly the same. In tourmaline, the terminations are never alike, with a few exceptions. One end of a crystal will be pyramidal, with steeply sloped prism faces that dominate the termination. These steep faces either come to a point or a tiny, flat termination. We call that flat face a pedion, or "C" face. The opposite end of the same crystal may be completely or nearly flat. It can also be slightly rounded and may have very minor sloping faces that modify the crystal termination. The fact that most tourmalines have this odd characteristic helps identify them.

Why is this so? Are these unmatched terminations evidence of some important property? Or are they just another oddity in the mineral world? Tourmaline is not the only hemimorphic mineral species, hemimorphite, which gives it name to this property, is just one common mineral with terminations that don't match.

The external appearance of a crystal reflects what's going on with its internal structure. Tourmaline molecules are arranged in tetrahedrons, slope-sided shapes of triangular faces that are wide at one end and pointed at the other. When these tetrahedrons stack to form a crystal, there is no orderly arrangement such as you get when you stack cubes or rectangular boxes. This is one reason tourmalines can play host to so many trace elements, the uneven stacking creates spaces and unattached electrical charges that can attract rogue atoms.

The classic locality of Dravograd, Slovenia, gave its name to the tourmaline variety dravite!



Yinnitherra, Australia, produced tons of brown dravite tourmalines some years ago.

Because of their disordered shape, the internal molecules cannot arrange themselves symmetrically, and that is the key. Symmetrically arranged molecules have what is called a point of symmetry, or a plane of symmetry, a central point or plane around which everything else develops in mirrorlike positioning. By turning a crystal that has a plane of symmetry you can see repeating faces that match. If you sliced a symmetrical crystal right down the middle, each half would be a mirror image of the other half. This is a bit of oversimplification, but you get the idea.

Now cut a tourmaline in half longitudinally or laterally, it matters not which direction, as long as the cut is perpendicular to the prism. The two halves won't match; they are not mirror images of each other. There is no plane or center of symmetry. So what's the significance of this?

When a crystal lacks symmetry, it develops polarity, meaning opposite ends of the crystal have opposite electrical charges. This polarity is what results in hemimorphism in tourmaline, and leads to a couple of really interesting properties called pyroelectricity and piezoelectricity. These properties are best seen in the gem crystals. In schorl and buergerite and the opaque types of dravite, the polarity is weak, and in some cases hemimorphism isn't even evident. There is a cause-effect relationship to hemimorphism and lack of symmetry in a crystal.

continued on next page

Referring to the pyroelectric property, the Germans used to call a tourmaline crystal "aschentrekker," which means "ash attractor." If you heat a tourmaline gently, or rub it vigorously, then sprinkle ashes over it, one end will collect more ashes than the other. This is because the opposite ends of the crystal are positively and negatively charged. This is an interesting property, though little used except for identification.

The piezoelectric property, however, does have some important uses. The term gets its name from the Greek word "perzein," which means "to press." If you compress a slice of a tourmaline crystal, it will develop positive and negative ends. The harder you press, the stronger the electric charge. With sensitive instruments, changes in these electrical charges can be detected. This property can now be used to detect subtle changes in pressure, like the change in ocean pressure as a vessel goes deeper. It also has similar industrial applications.

Tourmalines tend to have a hardness of Mohs 7.5, so they make good jewelry stones. While their color is generally a delicate hue, lacking intensity, the gemmy elbaites and liddicoatites can exhibit just about every color of the rainbow. While most uvites and dravites are monochromatic and opaque, some are transparent and gemmy, with a pleasing yellow or green color, and in one rare Zambian case, a bright red.

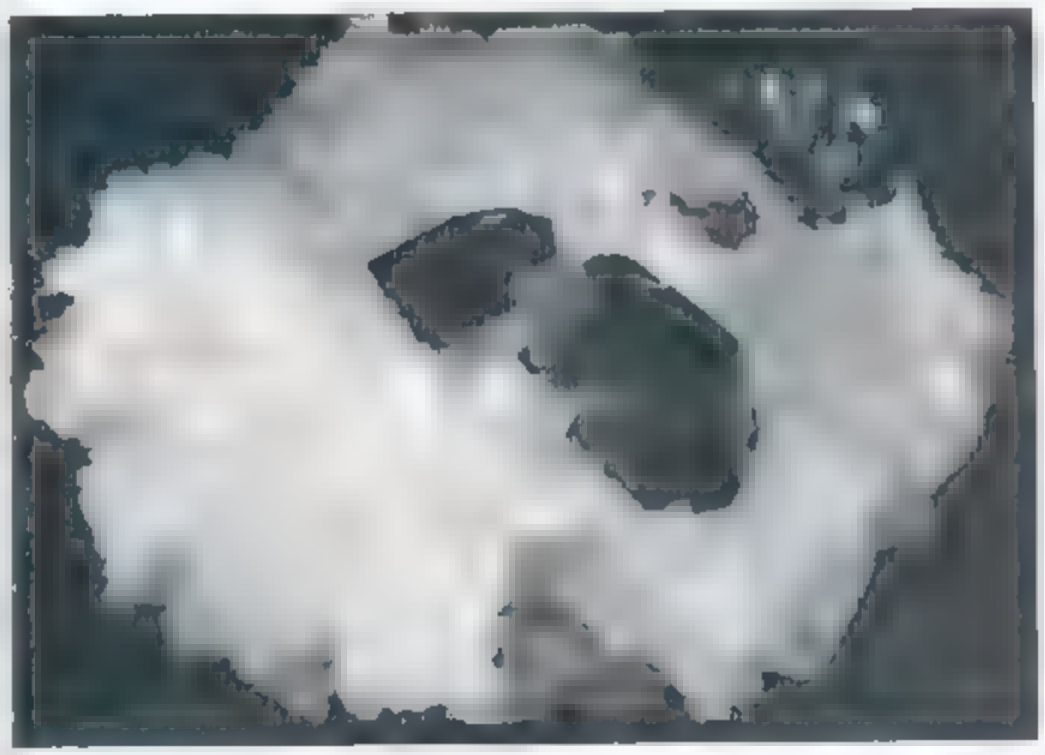
In a very broad sense, you can use the color of a tourmaline to get a sense of its temperature of formation. The black schorls form at the highest temperature of the group. When the proper ingredients are present, it tends to form above 300 degrees Celsius. The browns and greens start forming at about 290 degrees Celsius, while the lovely pinks and reds form at about 150 degrees Celsius. These references were the result of studies done in Russia on a variety of crystals from known deposits.

Like so many other minerals, the tourmalines form as a series. There is a regular sequential relationship within the group. Visualize a triangle and place elbaite, dravite and schorl at the three corners of the triangle. These are considered the pure end members of the tourmaline group. The problem in nature is that pure end members just don't form, again partly due to tourmaline's promiscuous coupling with random atoms. Among those three end members, other tourmalines develop. Scientists refer to the three resulting series of species as a mix of elbaite-dravite, dravite/schorl or schorl/elbaite. In fact, you sometimes find an elbaite or liddicoatite crystal whose outer zone is actually schorl.

So the rock type in which a tourmaline forms, the conditions under which it forms, the temperature of formation, and the available chemical ingredients determine what the end product will be. All of which brings us to the types of rock in which you might find tourmalines.

The best-known source of tourmaline is the complex, or Li-Rb, pegmatites. That's because the largest, finest, gemmiest and most valuable tourmalines are found in complex pegmatites. Naturally, these deposits get the lion's share of attention.

Coming in a distant second are the contact-metamorphosed limestones, which produce non-gem tourmalines, but can produce fine gemmy tourmalines in limited numbers.



Sharp, doubly terminated uvite crystals on magnesite are collected from a magnesite mine in Brumado, Bahia, Brazil.

Other sources of tourmalines include rocks like crystalline schists and gneisses that formed by fumerolic action. When hydrothermal solutions invade a country rock, it can form pneumatolytic zones, in which nongem tourmalines can grow. The ore veins of Cornwall, England, are an example. The tourmalines there are not gemmy, but form good crystals. Finally, tourmalines are found in contact metamorphic zones.

Evidence of tourmalines is found in rocks that are said to have been tourmalinized. This happens when solutions invade country rock and massive tourmaline replaces mica. If the action continues, it will even replace the feldspar in the rock.

While tourmalines never form in sedimentary rocks, some of the world's great gem crystals are found loose in the detritus resulting from the weathering of tourmaline-rich rock formations. In fact, the vast number of gem producing pegmatites, including the great deposits of Brazil, seems to have been found by tracing float crystals to their source. In fact, an estimated 70 percent of the gem tourmalines found in Brazil have been dug out of the graves and clays at the bottom of pegmatite-bearing slopes.

Another important gem-producing area in Afghanistan was discovered by geologists who were mapping the high Himalayas. They stumbled on to debris fields loaded with tourmaline, kunzite, and other pegmatite minerals. Production from this 1970s discovery is still going on, and seems to have encouraged later finds in Pakistan, as well.

Another property of transparent tourmalines is dichroism, a form of pleochroism in which two different colors, or intensities of the same color, can be seen when the crystal is viewed at two different angles. A lot of mineral species show this phenomenon. This phenomenon is due to the internal atomic structure of the crystal, which lets light pass through more readily in one direction than in another. Because tourmaline is a hexagonal crystal, it shows changes in color intensity only. Crystals that are not hexagonal or tetragonal may show changes in color intensity, but may also show two or more different colors when viewed from various angles.

You've undoubtedly noticed that many tourmaline crystals, primarily schorl, elbaite and liddicoatite, show vertical striations. These also help identify tourmaline. The striations are due to oscillatory growth. As the crystal grows, the conditions under which it is developing change, often subtly. Under one set of conditions, the crystal may develop as a normal hexagon with smooth faces. This is common in dravite. But when growth conditions change, the crystal will suddenly start growing trigonal faces at a slightly different angle than the hexagonal faces. The alternating growth patterns create grooves, or striations. Black, nongemmy schorl may or may not have striations. Opaque uvite, dravite and buergerite usually lack striations or exhibit just a hint of them.

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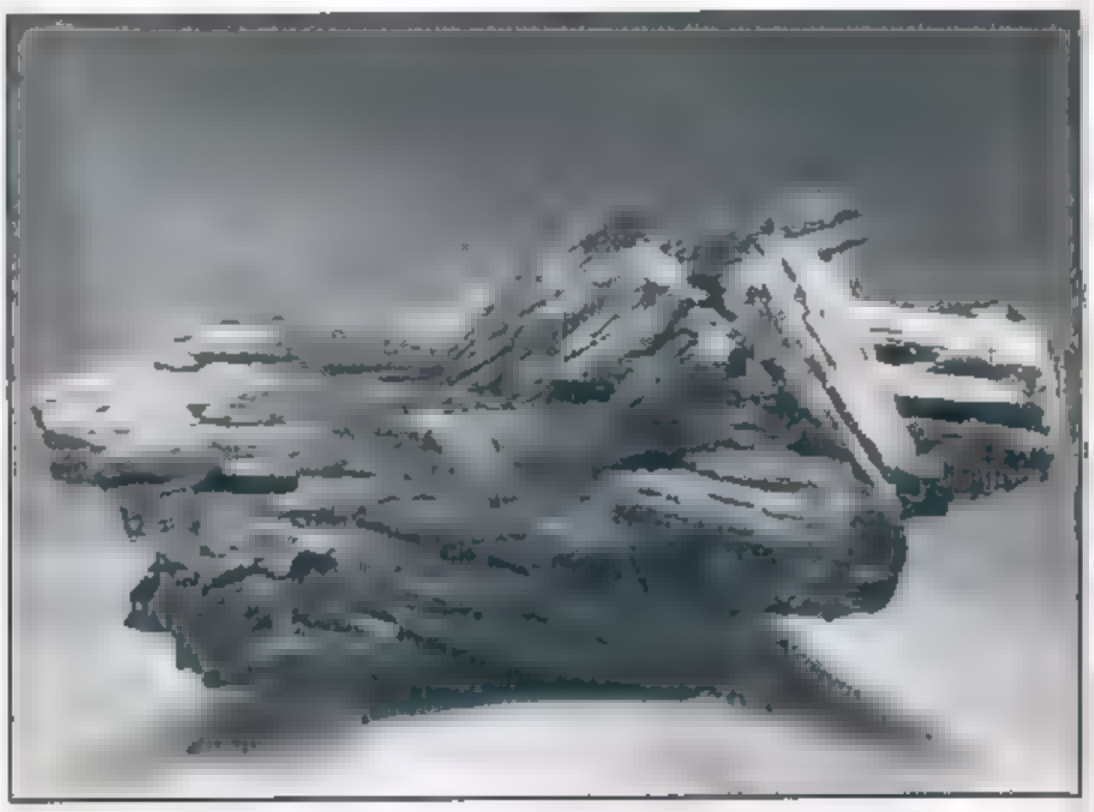
The Frugal Collector: The Tourmaline Group *from page 43*

The more common tourmaline species is schorl. It occurs in shiny to dull, prismatic, striated crystals or in short, stubby crystals that lack striations, and it can even be found in black, velvety crystals that taper almost to a rounded point, have a sparkling velvet surface, and show deep striations. These are very attractive. The best source of this velvet schorl has been a tungsten mine that was worked for gemmy scheelites, located just south of the Arizona border in Sonora, Mexico. The better crystals are 4 and 5 inches long, and clusters of them can be found in flat plates a foot or more across.

Schorl is a ferrous iron tourmaline. In pegmatites, it is frequently found around the borders of the deposit, even extending into the country rock. Such crystals can approach a foot in length or be simple, tiny, black needles that form in sunbursts, crystals radiating from a central point. The largest reported schorl measured 9 feet in length and was found in the outer zone of a South Dakota pegmatite. In most cases, it is impossible to collect these black beauties in the country rock, as they are locked tightly in the host rock and tend to crumble easily. Fortunately, there are several sources of display-quality schorl.



The best source of velvet schorl has been a tungsten mine in Sonora, Mexico.

The American classic locality is Pierrepont in St. Lawrence County, New York, where stubby, brilliant, black crystals lacking striations are found in tightly stacked clusters, with the larger crystals reaching 2 inches or longer. Just about every mineral book describes these lovely non-gem crystals as schorl. The locality has been collected by amateurs for decades, and was even mentioned in a New York State geology text as far back as 1813. Eastern collections especially have excellent examples of these fine schorls. The only problem is the black tourmaline crystals from Pierrepont are not schorl!

This misidentification was easy to make years ago, when mineralogy was still in its infancy. Recently, careful analysis of the Pierrepont tourmalines has shown that their magnesium content is greater than their iron content, and this classifies them as uvite, the magnesium member of the tourmaline group, which I will describe later. If you have a Pierrepont "schorl," change your label!

To collect or obtain schorl, one has only to look to the many pegmatite deposits in America. The black crystals can occur in simple pegmatites, as well as in those that are chemically complex. Right in the Phoenix area, for example, black schorl crystals were commonly collected by college students from a simple pegmatite. I used to take my student groups there every year. Unfortunately, wealthy people built their mansions all over the pegmatite outcrops, and closed the area off to students. Just because kids were digging up their backyards and hammering on the rocks there seems to me to be a poor reason for closing off an area with educational value.

Still, there are any number of collectible pegmatites to be found in North Dakota, North Carolina, New England, Colorado, and California, with lesser known sites in several other states. Since the black schorl crystals are often embedded in the pegmatite rock and offer little or no specimen or gem potential to miners, most of the schorl-bearing rocks are cast aside to the dump! The crystals are often only marginally attractive, are often damaged when removed, and are usually tightly embedded in the graphic granite of the pegmatite.

The demand for schorl is minimal, but fine specimen-grade crystals, free-standing on matrix, are coming from Afghanistan, Pakistan and Brazil. These hold no appeal for the gemologist if they are not gemmy internally, so the price is within painful limits for the Frugal Collector. Check out the myriad black tourmalines from Stak Nala, Pakistan, for example. They are tipped with a nice green color change and skirted with albite plates. Internally, they have a pink color, but unless the dealer looks, this may pass unnoticed, and the buyer will get a bargain. The Stak Nala crystals were mined in great abundance so you ought to be able to find a decent example these days. However, dealers tend to stock only those specimens that are attractive and will sell quickly. The trend away from interesting localities or scientifically interesting species is appalling, but is a fact of life, as sales control what dealers prefer to stock. For these reasons, you see very little specimen schorl for sale at shows, save for the brilliant black prisms from New York (remember they are uvite), Brazil, Afghanistan, and Pakistan.

Except for one good deposit in Mexico, buergerite wouldn't even be included in this discussion. Like schorl, buergerite is an iron-rich tourmaline. But while schorl's iron is bivalent, meaning each iron atom has two electrons to share in a reaction, buergerite's iron is trivalent, with three available electrons, so different properties result.

The collector specimens you'll see are all from the same locality in San Luis Potosi, Mexico, somewhere near the town of Mexquitic. The buergerite is flat, radiating sprays of milk chocolate-brown prisms. They are usually under an inch long, but in subparallel clusters, often resting end to end to extend several inches across the fine-grained tan matrix. The largest crystals I've seen of this material reach 4 inches long, but lying flat in matrix. I've yet to see a free-standing buergerite. The crystals are not striated and have good luster, but do not show good hemimorphism. Still, these specimens were available in abundance some years ago, and the odd specimen shows up now and again and is never expensive, in spite of buergerite being one of the uncommon tourmalines.

Interestingly, the deposit that produces buergerite is probably not exhausted, but no material is forthcoming simply because the old fellow who was mining the specimens has died and didn't tell anyone where his mine was. One of these days, someone will stumble on the old workings and the supply of buergerite will be refreshed.

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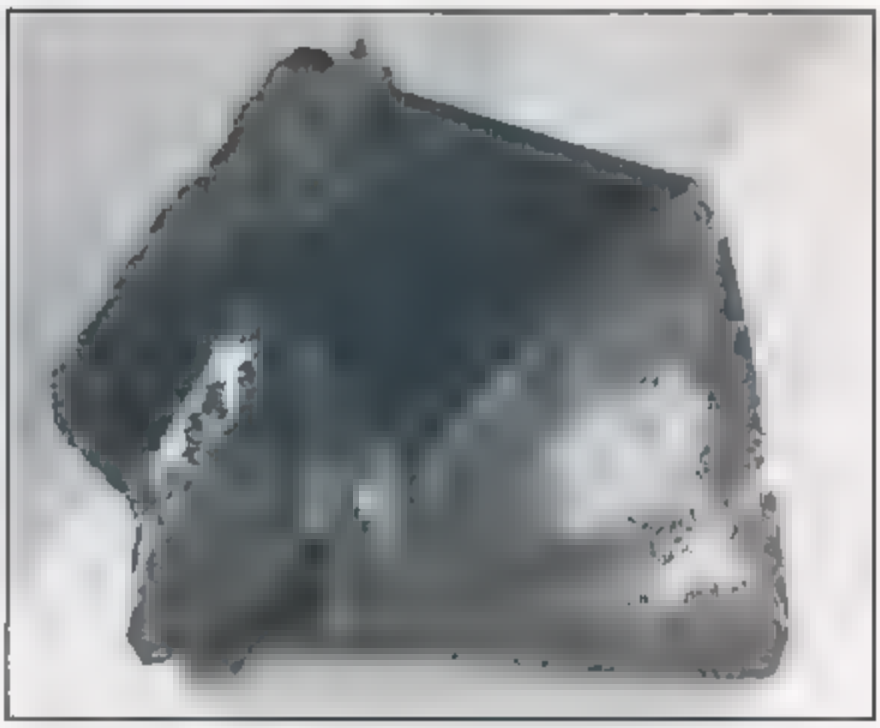
The Frugal Collector: The Tourmaline Group *from page 45*



The triangular cross section of this Namibian schorl is commonly seen in tourmalines.

Dravite is a sodium magnesium tourmaline. Its claims to fame are that it can occur in metamorphosed limestones or dolomites, and is usually opaque, but can be gemmy. The original dravite came from Drave, Austria, hence the name. Other deposits in Europe have produced nondescript specimens of this uncommon tourmaline. None produced gem-quality crystals. However, about 20 years ago, Zambia surprised the gem world by producing gem-quality red to brown-red dravites that were cuttable and quite attractive. The crystals occurred in a metamorphic environment and showed the typical hemimorphic habit of tourmaline. They were collected near Chipata, Zambia, and are not unlike crystals found in Kenya another source of this rare gem.

Like buergerite, dravite would be more of a curiosity than a collector mineral, save for one occurrence, and what an occurrence! In the outback of Western Australia is a small locale called Yinnietherra. When prospectors found an outcrop of hydrothermally altered rock fraught with big, brown, triangular tourmalines, it proved to be the most productive, most abundant deposit of dravite ever found anywhere. In addition, the crystals were the largest ever found: some upwards of 3 and 4 pounds, 7 or more inches long, and 2 to 3 inches across. Embedded in an altered mica, which sometimes sticks out of the prism faces of the crystals, these flat-sided crystals have a perfect triangular shape, the other three prism faces are missing, or are only thin, flat surfaces. The crystals, never seen on matrix, show perfect terminations, which, incidentally, are not hemimorphic. The faces are smooth, lacking striations. When these uncommon dravites hit the shows, they took the collector world by storm. The number of crystals mined is not known, since the mine operators did not take account. Instead, they reported mining tonnages of loose crystals! These remarkable examples of dravite came to light around 1970, though the deposit has been known since about 1918. So many crystals were dug that you still find them for sale today. The larger ones are in collections, but nice 1- and 2-inch perfect trigons can still be found by carefully checking dealer tables.

The last member of the tourmaline group I will describe is uvite, a relative newcomer to the tourmaline groupings. It was theoretically described and named as far back as 1888, but it was nearly 100 years later when modern researchers actually proved its existence. As it turns out, it is more common than previously thought, because many tourmalines thought to be schorl were actually shown to be uvite.

Uvite forms best in metamorphosed limestone; the host rock is often referred to as marble. Certainly, the best-known locality for uvite, aside from Pierrepont, is the Franklin, New Jersey, area. While the Franklin uvite does not occur in the ore bodies themselves, it is found sparingly in the surrounding limestone. Years ago, I recall collecting a minor yellowish crystal in the limestone of what was called the Pistol Range Quarry. The crystal was the size of the first joint on my little finger, dirty yellow, and somewhat rounded. It was cloudy, but light did pass through it. Later, I realized I had collected a uvite, but only after I had traded the piece away!

Collectors of Franklin-Sterling Hill minerals eagerly add a nice uvite to their area collection. Most crystals are only an inch or so long, tend to be rounded, show no striations, and have to be worked out of the enclosing matrix, since they do not form in open spaces in the metamorphosed limestone. The crystals do not occur in quantity, so the Frugal Collector should look to the Pierrepont source for uvite as to be added to a collection.

Part II will feature the two most popular and valuable members of the tourmaline group, elbaite and liddicoatite, and the oddity achroite.

ROCK & GEM

Halite

by Amy Dodson, age 11

Halite is the most common mineral on your kitchen table, and it is also known as rock salt. I looked up halite in Webster's dictionary and found that it can be pronounced *hal*-ite or *hā*-lite. Salt is sodium chloride, and it is easy to tell that it is halite by its taste.

Halite's color is usually clear or white, but sometimes it is blue, purple, pink, yellow, or gray. The crystals are transparent to translucent cubes. Halite's Mohs hardness is 2 and its streak is white.

Halite can be found all over the world where ancient salt lakes and seas have evaporated and have left salt deposits behind. Large salt rocks are mined from underground deposits.

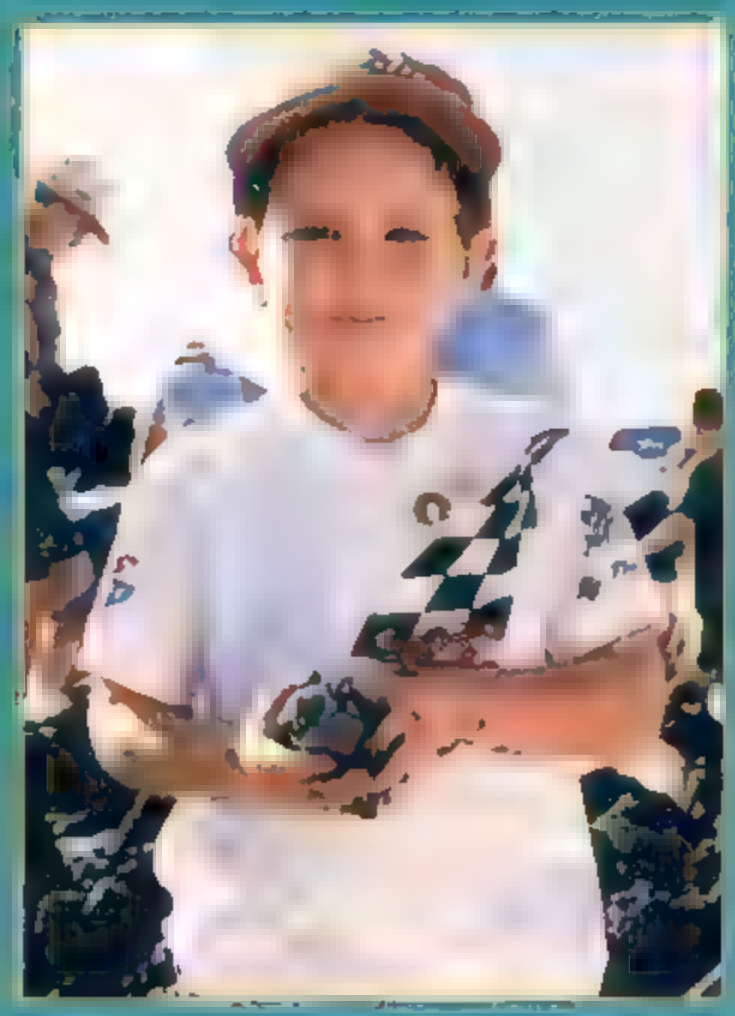
Most halite that is mined in the United States is used to melt snow and ice from roads and sidewalks. This makes them safer for people to travel on. Rock salt is also used in water softeners and in the old fashioned hand-cranked ice cream machines. It is also compressed into salt blocks for farm animals. Animals in the wild make paths to salt licks, which are natural halite deposits. Halite is important in the diets of people and animals, because salt is needed for wounds to heal. Tears, sweat and blood are salty.

Halite is an interesting mineral to have in your collection. When people see my halite they always say, "What is that?" and want to give it a lick when I tell them it is salt.

Kids in the Field

Ventura (California) Gem & Mineral Society member Emma Mayer caught some of her club's junior members on film enjoying their hobby. Share your photos and finds with us! Send photos (copies only, please) and a short caption for each to **Rock & Gem Kids, 290 Maple Ct., Ste. 232, Ventura, CA 93003**.

Walt Horenas, of Camarillo, California, collected gastropod fossils in the Miocene shale of Topanga Canyon.

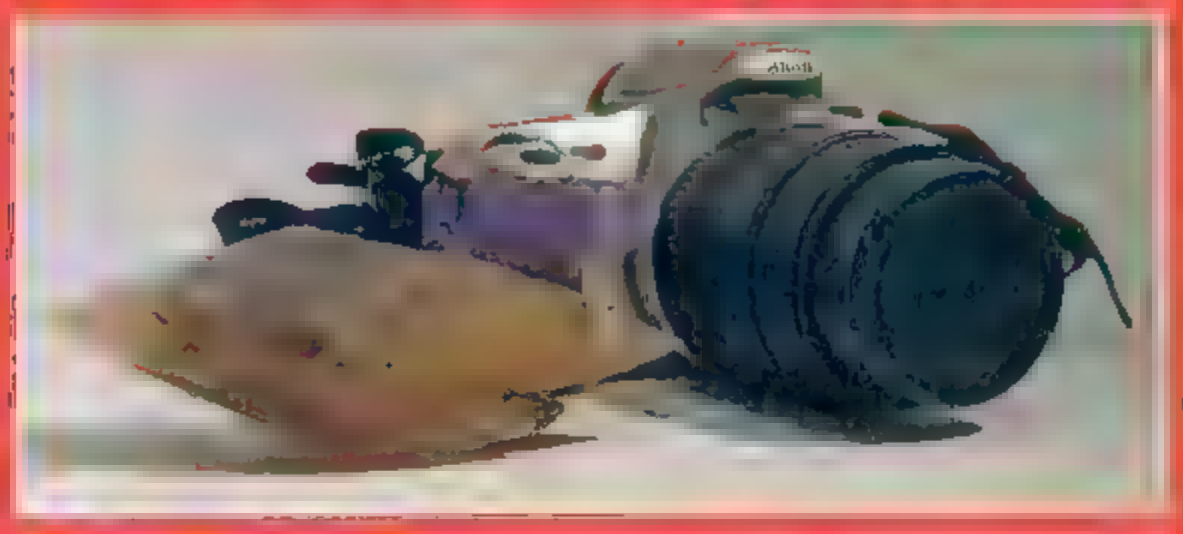


Logan McCormick, 6, of Ojai, California, holds a hanksite specimen he found during the Searles Lake show.

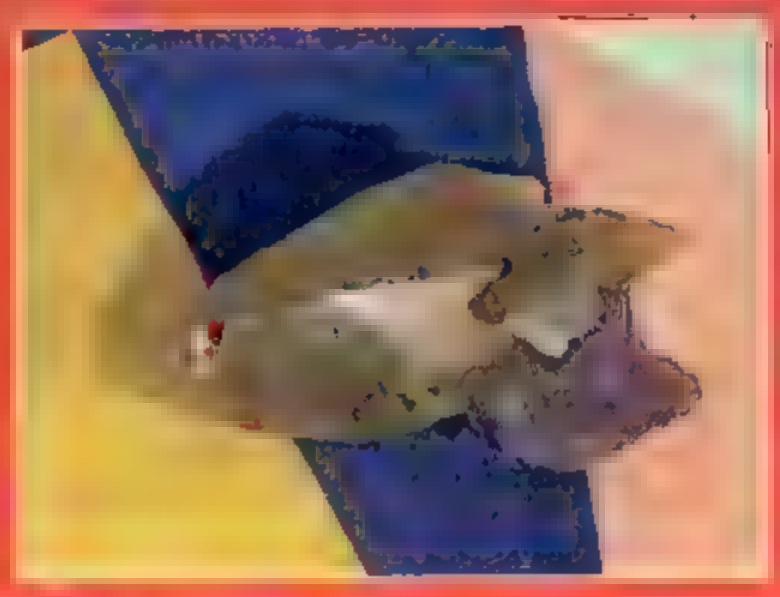
KIDS

by Steve Smith

Mineral Photography



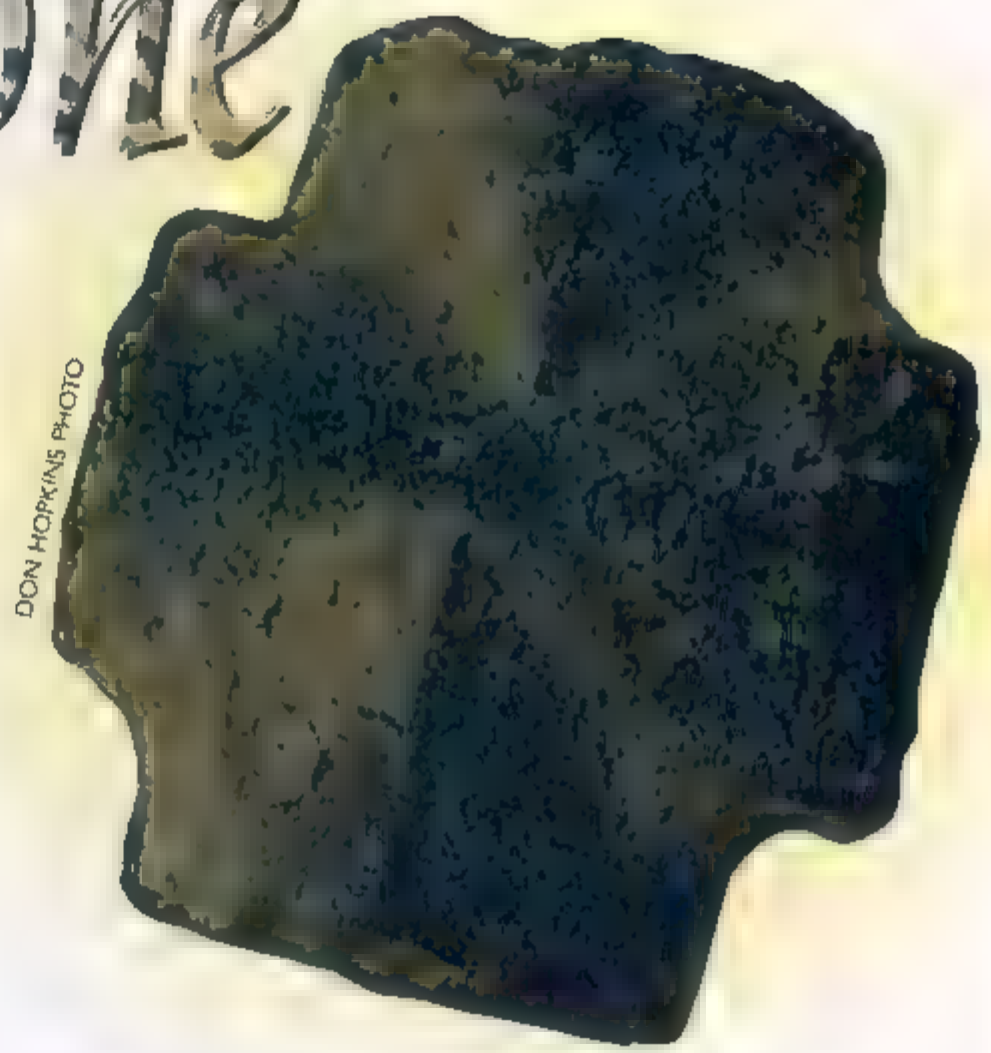
Rock & Gem Kids Quiz



Fairy Stone Fixation

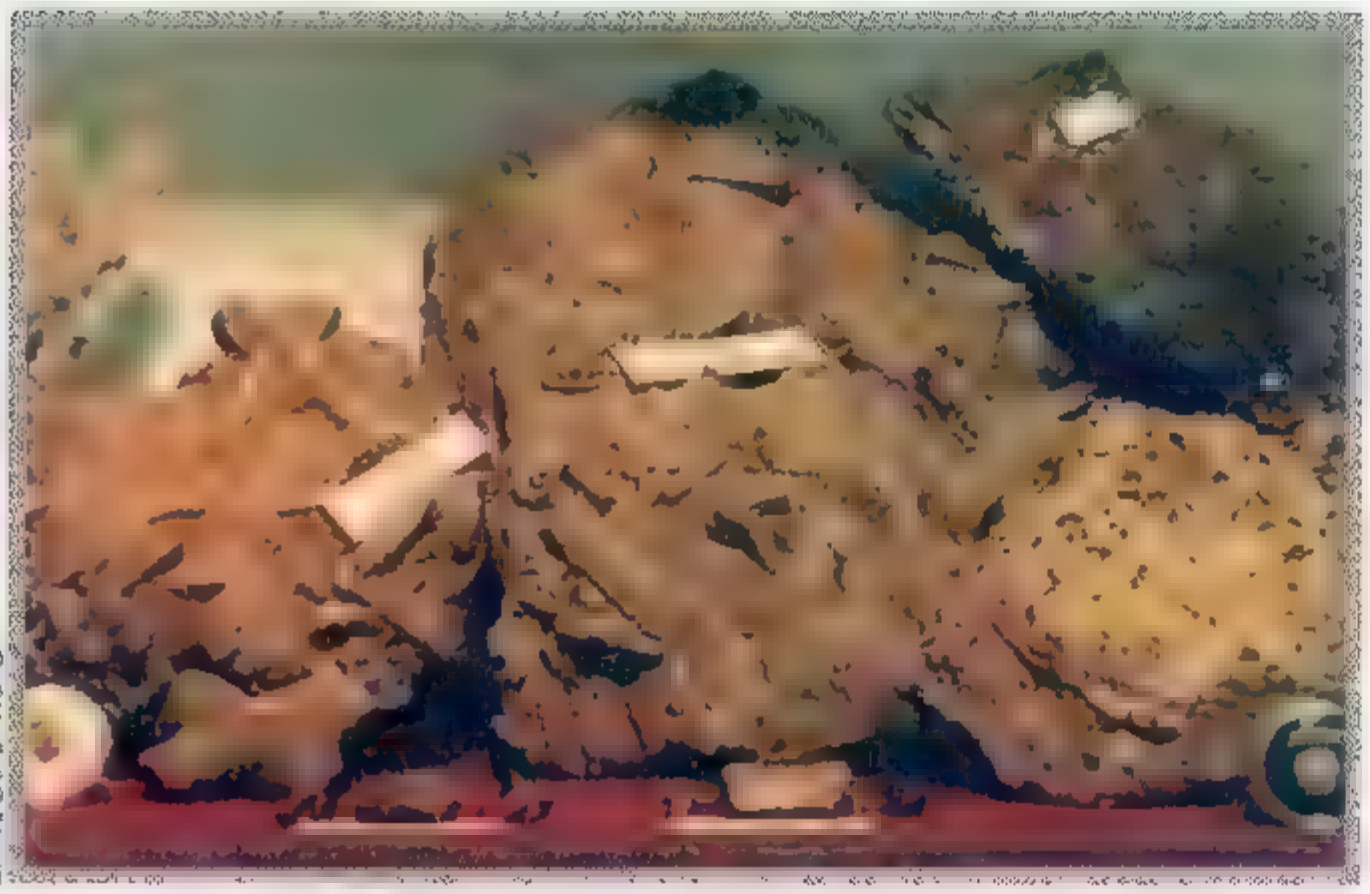
A New Museum Spotlights Staurolite

Story by Lori Lamb



DON HOPKINS PHOTO

Maltese crosses of this clarity are particularly prized by collectors.



DARY L. LAMB PHOTO

The Stone Cross Mountain Museum displays staurolite crosses from places other than Virginia, including North Carolina and Georgia.

DON HOPKINS PHOTO

A rare Roman cross in matrix is on display at the museum, and you can even touch it!

One of my fondest childhood memories occurred when I was around 6 years old. It was Labor Day, and we had gotten up early to go on a picnic in Virginia. From our home in North Carolina, it took over three hours to reach our destination, but my dad said it was special because we could find "fairy crosses" there. The place was Fairy Stone State Park, just a few miles to the northwest of Martinsville, Virginia. I remember walking through the woods with a small burlap bag, finding "crosses" scattered in the dirt. Looking back 35 years later, I guess this was the first time I collected actual mineral specimens, as opposed to gravel in the driveway.

Of course, the fairy crosses were actually penetration twins of staurolite crystals, weathered out of the schist country rock. Back then, the locals claimed that this was the only place in the world these crosses were found. I have learned over years of collecting that staurolite crystals are found at other places in this country and around the world. Naturally, singles are more common than twins. And though I have hunted many of the other famous staurolite localities, from New Mexico to Georgia to Maine, I must say for sheer volume, the area around Fairy Stone State Park is the most prolific.

Now a longtime collector has opened a museum to the public that features staurolite. Stone Cross Mountain Museum is located on U.S. Highway 58 in Henry County, west of Martinsville and not far from my youthful haunt of Fairy Stone State Park. Since I enjoy collecting staurolites, when I learned of the museum, my family and I headed up for a visit. The museum is the dream of Don Hopkins, a gentleman who has collected Virginia staurolites for close to 25 years. Don met us at the museum where, as owner and curator, he spends much of his retired time. We received a personal tour and a history of the genesis of the museum.

Don actually came to collecting somewhat by accident. Years ago, he purchased a parcel of land just outside Stuart, Virginia, in Patrick County. In order to secure adequate water flow to his property, he purchased an additional 13 acres, which contained the head of the spring he used. One day after he had dug out the spring, he found a single staurolite cross in the bowl. Curiosity prevailed, and he found numerous other crystals in the dirt around and above the spring. At this point, he claims, he got serious about collecting. He hired a bulldozer to clear some sections of his land and searched for staurolite crosses in his spare time.

The country host rock in the area is schist, a metamorphic rock that is frequently host to garnets, staurolites and kyanite. The region covered by these outcrops extends from Patrick County into Henry and Franklin counties to an area around Smith Mountain Lake. Staurolite is an iron aluminum silicate, always occurring in crystallized habit, mostly in regional metamorphic schists. It is frequently associated with almandine garnets, and may even have small to microscopic garnets embedded in its crystals. The presence of staurolite in a metamorphic rock is a hallmark of pressurized formation and reveals information about the temperature and pressure at which the particular rock was formed.

George Barrow, a Scottish geologist in the 1800s, first observed minerals occurring in sequential patterns in schists. He noted a sequence from biotite, to almandite (almandine garnet), to staurolite, to kyanite, to sillimanite, though he did not quite understand the reason behind the pattern. Later geologists found that varying combinations of temperature and pressure would produce certain minerals in schist, with garnets forming at lower temperatures and pressure, staurolite at the midrange, and kyanite and sillimanite forming at the highest temperatures and pressures. Frequently, the staurolite crystals are twinned, and over time, weathering releases the crystals to be found by the astute collector. Local folklore claims that the crosses were formed by the tears of angels or fairies at the crucifixion of Christ, hence the name fairy crosses.

Over years of collecting, Don acquired numerous gallon jars full of crosses and several banana boxes full of matrix pieces, large pieces of schist with crystals embedded in them. In an effort to get organized, he began sorting and cataloging his collection, a task that took two and a half years. He then built cases and tray boxes to display his many and varied specimens. Then in December 2002, he opened the Stone Cross Mountain Museum.

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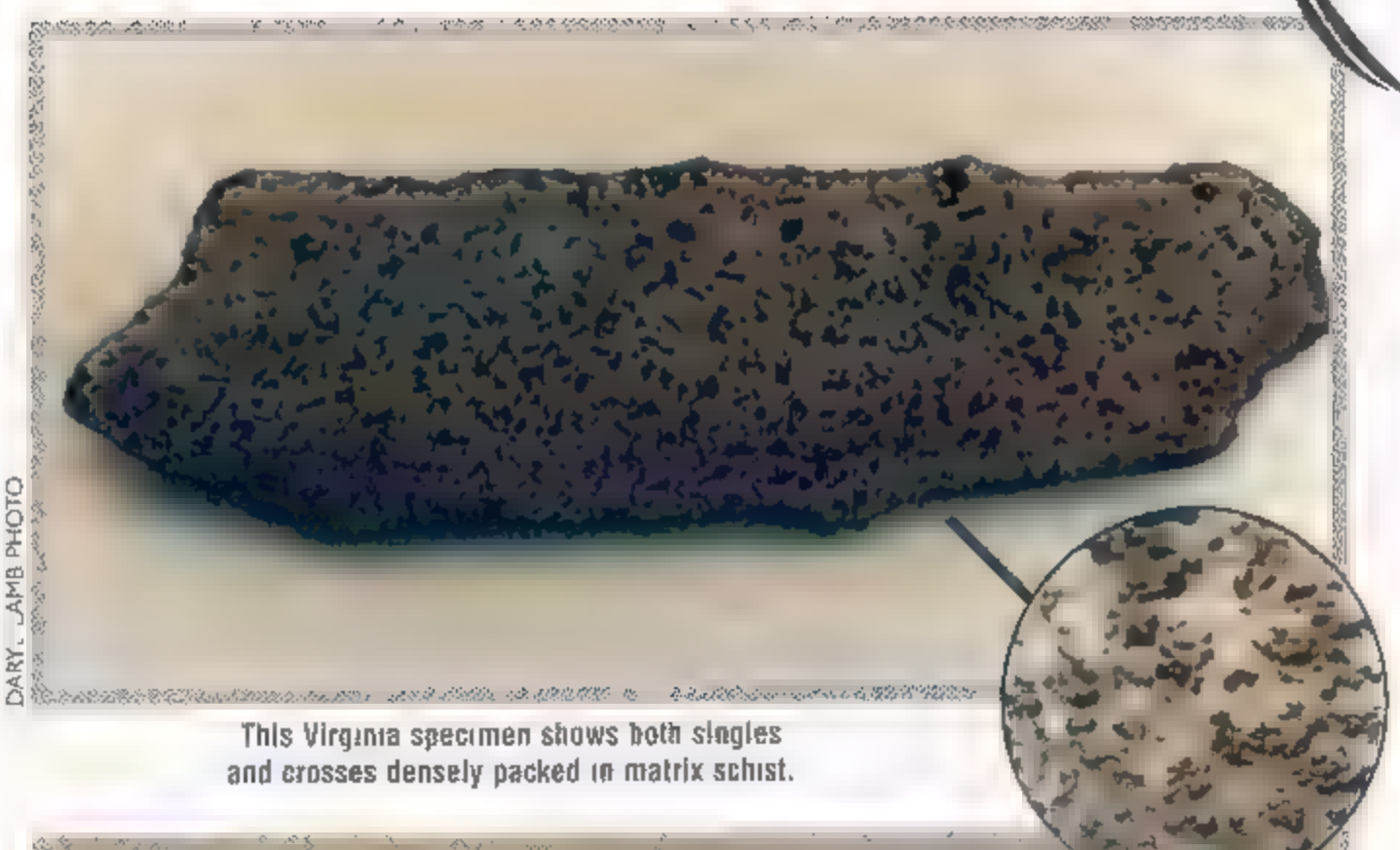


DARYL LAMB PHOTO

This Virginia specimen shows both singles and crosses densely packed in matrix schist.

DARYL LAMB PHOTO

The various types and sizes of staurolite crosses and single crystals are well represented in the museum's displays.

DARYL LAMB PHOTO

Curator Don Hopkins, right, is always eager to show his many specimens and to educate visitors about staurolites.

Fairy Stone Fixation *from page 61*

The museum is indeed committed solely to staurolites, but not just Virginia specimens. Don has arranged his collection into 34 display cases around an L-shaped room. The first case has several pieces of matrix schist with staurolite crystals from Virginia, Georgia, and North Carolina. It also features examples of the washing baskets cleverly designed by Don to clean the individual crystals. I have found from experience that it takes more than one simple scrubbing to remove the red clay that tightly adheres to the crystal floaters. Don explained that he places crystals in the modified cricket basket and agitates them through up to 10 buckets of water before the crystals are clean enough to be truly appreciated.

The museum theme is structured around an evaluation or comparison of several variables related to the staurolite crystals. The largest display includes more than 400 crosses from the immediate area and serves to summarize the many variations of crosses that can be found. Other displays focus on variation in color, size, shape, and quality, or "perfection." Still others compare and contrast matrix specimens. Though it is impossible to review each display here, some are worth highlighting.

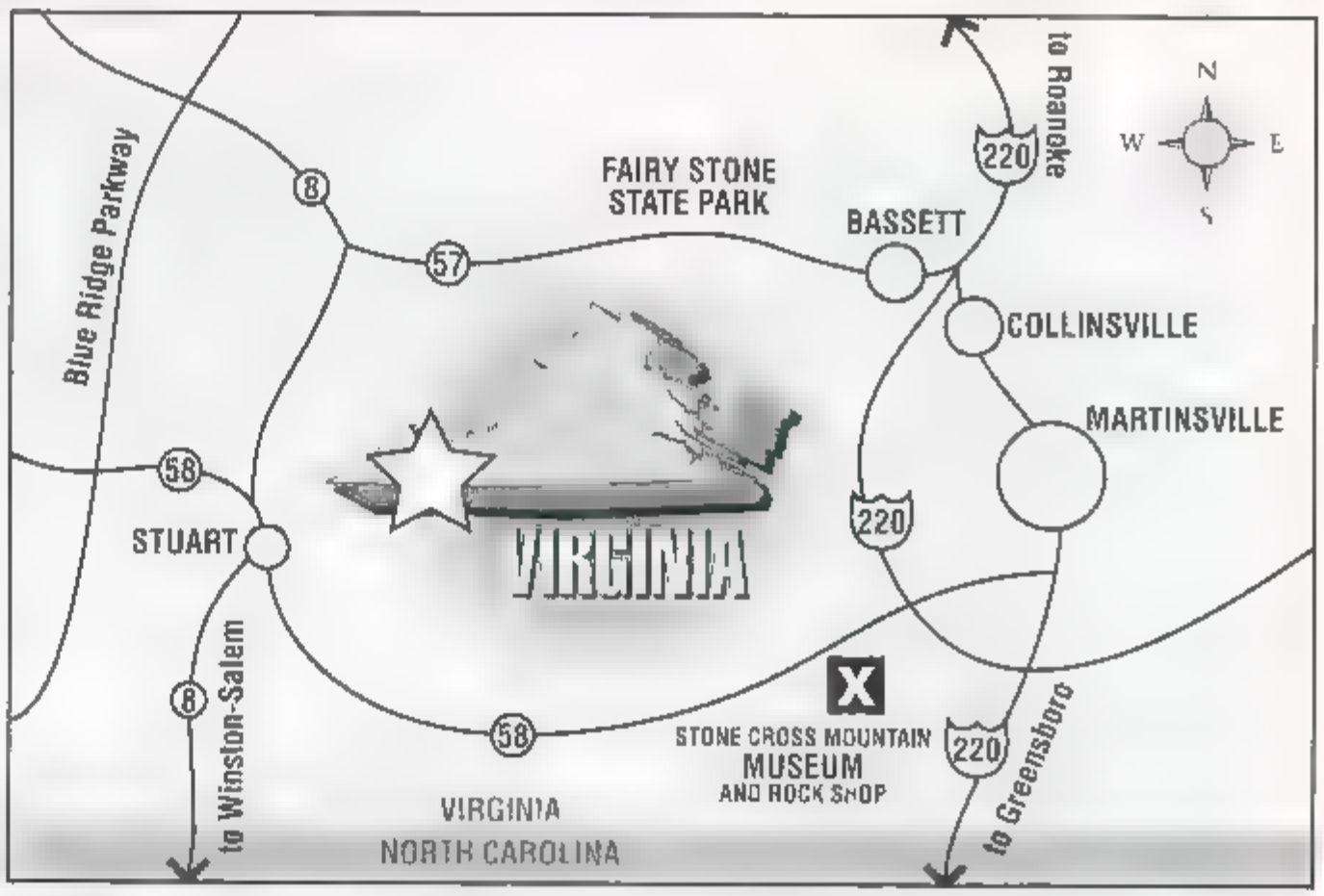
The cruciform shape of the penetration staurolite twin has long fascinated collectors. There are three basic cross shapes: the Roman, the Maltese, and the St. Andrews. Each of these shapes is well represented in the museum, though the most common is the St. Andrews. The St. Andrews cross' penetration angle forms two opposing acute angles of approximately 60 degrees and two opposing obtuse angles of 120 degrees within the same plane. However, there are endless variations on the combination of angles, and the placement of the point of intersection. Some have centered crossbars that produce segments of equal length, while in others the point of penetration is off center, creating two shorter and two longer segments.

The size of the penetrating crystal can produce additional variation, with some being substantially smaller than the host crystal. An ideal specimen would have two single crystals of equal size and shape penetrating at each midpoint and forming the 60-degree and 120-degree angles. Don has some exceptional examples of these. Most St. Andrews crosses in Virginia are 1 inches or smaller. However, specimens from other regions of the country are larger. The largest cross on display at the museum is a St. Andrews from Fannin County, Georgia, measuring 6 inches tip to tip. Many of the Georgia specimens are 2 to 3 inches in length, though they are not as crisp in detail. North Carolina specimens measure around 1 to 3 inches in length.

A less common, but still findable, form is the Maltese cross, in which penetration has occurred at the midpoint of both crystals, forming right angles at about 90 degrees. The crystal resembles a "plus" sign. Variations can occur when the single crystals are not the same thickness or length. In extreme instances, the penetration twin is dwarfed by the larger host crystal, producing a "bowtie" effect within the specimen. These are actually fairly common finds, while the true, distinct Maltese and its cleanly extended equal segments are much more rare. Even so, the museum collection has numerous exceptional and very aesthetic Maltese crosses, inspiring one to run out and start digging.

The rarest cross type to find is the Roman cross, which, as the name implies, resembles the cross the Romans used for crucifixion in ancient times. These are the most desired crystals. Don's collection includes numerous matrix pieces with Roman crosses embedded in them. Attempts to extract crosses of any shape from the schist matrix tend to be unsuccessful, as the leverage of the extraction usually fractures the crystal. However, one can occasionally find a Roman floater and there are some nice ones on display at the museum. The largest Roman cross is a 4-inch beauty from Fannin County, Georgia.

At least as rare, or maybe even rarer, is the rosette. This occurs when three single crystals penetrate each other at a single point in the same plane, causing a flower-shaped specimen. The museum has floater and matrix specimens of rosettes, as well. In all my collecting years, the only one we have found is in my son's collection, thanks to his keen eye.



Of course, the most commonly occurring shape is the single staurolite crystal. Finding well-formed and undamaged single crystals is not as easy as one might think. They, too, have variables in shape and size that make each one different. To demonstrate this, down one entire wall of the museum, Don has arranged a graduated parallel display of all four shapes—single, Roman, Maltese, and St. Andrews—increasing from approximately ⅝ inch to 6 inches. Each row contains a meticulous layout of 72 very similar specimens differing only slightly in size. The singles are the largest, with crystals from Cherokee County, North Carolina, and Fannin County, Georgia measuring 4 inches to 6 inches. These crystals, though, are much more weathered, with lines that are not as sharp and distinct as in the smaller crystals. Many of them have very small garnets embedded in them, or pocklike holes where garnets have weathered out. This coexistence with garnets, especially almandine, is common, as previously mentioned, but it certainly seems more prevalent in the larger samples.

The shape of the single staurolite is classified as monoclinic-prismatic (pseudo-orthorhombic). Most have six sides, some with a perfectly hexagonal cross section, much like beryl. These crystals, though, are not always perfectly formed, and each side may not be equidistant from a center point. Often, four of the six sides will be more pronounced, with the remaining two being smaller or diminished to an almost indiscernible length. This causes some single crystals to appear to have more of a diamond-shaped cross section. Most, however, are somewhere in between these two extremes. Ultimately, single crystals can vary in length, thickness, shape, angle of orientation, and

cross section. Smaller crystals tend to have better definition, possibly due to the heavy weathering prevalent in larger crystals.

Another characteristic that is compared at the museum is thickness. This is somewhat related to size, but is not quite the same, since size primarily refers to the length of the longest crystal component. The thickness of individual crystals references the apparent blockiness of the mass and does vary both within and across locations. Those from the Virginia sites average ¼ inch thick, but can be almost paper thin. Crystals from North Carolina are thicker at around 1 inch, and some from Georgia are almost cubic at 1½ to 2 inches thick. Interestingly, the famous specimens from Kerry, Russia, are almost square in cross section as a result of their thickness.

Most field guides and mineral references list staurolite as brown to black in color. Don postulates, through his displays, that staurolites occur in five basic colors, the "same colors of the human race: black, brown, red, yellow, and white." The black and brown are intrinsic colors of this mineral. The reddish brown hue is also a documented color, though it does not occur as frequently. The pale yellow, blue-gray, and white are, to some, questionable, however, this, too, has an explanation. Many of the staurolites in the Virginia collecting sites have either totally or partially pseudomorphed to sericite, a mica-type mineral. This pseudomorphism, combined with the universal graying that accompanies the weathering and oxidation processes, causes the specimens to occur in varying hues of pale yellow, tan, blue-gray, and even white, presenting a wider spectrum of colors than one would expect.

Surface staining from the surrounding red clay can also influence colors. In my own collection, I have black staurolites from Connecticut, brown from New Mexico, very reddish brown from Windham, Maine, blue-gray from Georgia, and tan to whitish (after cleaning thoroughly) from Virginia. Again, the latter two are in various stages of pseudomorphism. The vast majority of staurolites found around Fairy Stone State Park are weathered or pseudomorphed to some degree. Truly black and brown specimens are rare.

Another characteristic that is affected by, and primarily explained by, both the phenomenon of pseudomorphism and the effects of weathering is the seeming variation in the hardness of staurolites that Don has observed. Using the simple basics of hardness testing, the specimens range from around Mohs 2 to about Mohs 7.5. The lighter the color, it seems, the softer the specimen. This is actually consistent with the fact that the lighter-colored specimens are really pseudomorphs to sericite, which as a mica-type mineral has a hardness of Mohs 2 to 2.5. The weathering process and oxidation will also alter the actual chemical structure, and subsequently the physical properties of the mineral, including hardness. Not surprisingly, the blacker, nonweathered specimens such as those from Taos, New Mexico, and Fannin County, Georgia, are the hardest. Interestingly, crystals without garnet inclusions are harder than those with embedded garnets.

This variation in hardness in the Virginia specimens provides a rationale for the abundance of matrix specimens in the museum. Given the rather small relative difference in hardness between the specimens and the matrix, many of the samples are best observed in situ. Don has numerous large matrix pieces on display, some covered with literally hundreds of staurolite crystals, mostly singles and St. Andrews crosses. He has marked any Roman or Maltese crosses with a small, white dot to make them easier to locate. This represents hours of observation and cleaning.

Of course, for any collector of a distinct mineral type, the ultimate goal is always to find the perfect specimen, or in this case, a perfect example of each of the three cross types and a textbook single. Fortunately, the museum collection contains more than one perfect specimen of each. To really highlight these, the best of the best are in a display case all to themselves. All I could do was gaze. Except for one exceptional Maltese cross my son has, I have nothing that can touch anything in that case. And the beauty is that they are all displayed just as they were found, not worked, filed, polished, sanded, or otherwise enhanced. These are truly the prizes of many years of diligent collecting. It goes to show that there really are exceptional specimens out there to be found.

Over the years, Don has traded with other staurolite collectors across the country and around the world. This has netted him crosses from the Kola Peninsula, Russia; Clarkia, Idaho; Taos, New Mexico; Royalton, Minnesota; France; Madagascar; and Australia. I was not aware that stauronte crosses were found in this many different locations. Others include Windham, Maine; Middlesex County, Connecticut; Allegany County, North Carolina; South Africa; and England. The Australia staurolites have a special significance, and given the story of their trek to the museum, I can understand why.

continued on next page

Fairy Stone Fixation *from page 63*

Back in 2002, a gentleman from Australia wandered into a small general store in Stuart, Virginia, inquiring about possible staurolite collecting sites. He was in the country visiting family, but as a staurolite collector he wanted to take advantage of any possible opportunities while abroad. Coincidentally, a friend of Don's who knew his collecting history operated the general store. Don and the Australian got together and made arrangements for a trade. Several prize Patrick County staurolites went back to Australia with the visitor. Upon return to his homeland, he and several members of a local mineral club donated staurolites from their favorite collecting site at Mount Isa, Australia. These were sent via basic sea freight, spending three months at sea before finally arriving in Virginia in December 2002, just in time for the museum opening. These crystals were small, loose and in matrix, and dark brown to black. There were numerous sizes and shapes, including three delicate rosettes, a rare gift indeed. There were enough specimens to fill a separate display case.

Even though the museum is only about two years old, it provides a comprehensive look at the staurolite mineral. And though there are numerous museums, large and small, around the country highlighting geology, natural history, mineralogy, or regional mineralogy, I am not aware of any other museum that focuses so in depth on a single mineral type, with such a number and variety of specimens. To encourage and educate the novice collector, there are numerous books and videos on collecting staurolite available in the museum gift shop. Additionally, there are some sample specimens, both matrix pieces and individually mounted crosses, on sale for those who prefer collecting the easy way. These are all authentic specimens, not manufactured copycats.

Of course, spending several hours staring at primo staurolite crosses whetted my collecting appetite, and since we were less than 20 miles from Fairy Stone State Park, we headed up to finish out the day. Actually, one cannot collect on the actual state park property, but a few miles east of the park on state Route 57, there is a service station with privately owned land upon which the owners allow, and actually encourage, collecting. It is the same place I visited 35 years ago, and I have been back frequently in recent years. A well-worn path leads back into the woods. Extremely weathered and somewhat tumbled staurolites are pretty quickly evident along the trail and in the bed of the wet-weather stream, but most of these are not distinguishable as crosses. The average first-time collector or curious tourist tends to look here, not venturing deeper into the woods. However, if you follow the path back about a half-mile and then watch for trails that lead up the ridge to the right, there are areas where previous "rock gophers" have dug. According to the sign at the trail entrance, digging is not allowed, so it was curious to find obvious holes.

The red clay here can be extremely messy, and if wet, will stain clothing permanently. Given this deterrent, and following good collecting protocol, we opted not to dig. The best approach we've found is to assess areas where the rain has washed off specimens left behind by others. This is less messy, too. We settled in and hunted for about an hour in an area about the size of a tennis court. The ground here was covered with staurolites, so we had to get down on hands and knees to pick out the really good specimens. We used kneepads to protect clothing and joints. The average specimen here is gray, or stained very red from the clay, and around ¾ inch in length. Most are fairly sharp, not rounded or worn, a testament to their newly dug status. Our efforts were rewarded with numerous nice singles, as well as a few nice St. Andrews and some pseudo Maltese crosses, though nothing as crisp as those at the museum. Still, they were certainly good enough to add to my Riker mount display of crosses back home.

By now we had put in a full, though very rewarding, day. The time at the museum was enjoyable and educational, a must for the new collector and a plus for the seasoned one. The hobby of mineral collecting certainly has gained an asset in the Stone Cross Mountain Museum, thanks to the commitment of Don Hopkins. His efforts at furthering the hobby of rock collecting and his appreciation for the simple beauty of these specimens is very refreshing. We could use more of this support and tangible enthusiasm as collecting sites across the county continue to disappear due to development and reclamation. For more information on the museum you can contact Don at (276) 957-4873, or visit his Web site, www.stonecross mountain.com. If you are in the vicinity of southwest Virginia, take some time for a visit. I think you will find it worthwhile.

FOSSILS IN

Visit Cancún for Its High Life or Its Ancient Life

Story and Photos
by Dan and Carole Nielsen

Most people go to Cancun for white-sand beaches, diving on the coral reef, and the night life. While we enjoy all those things, my wife, Carole, and I recently visited Cancún primarily to hunt fossils and explore ancient Mayan ruins.

Cancún sits on the northeastern tip of the Yucatán Peninsula in the state of Quintana Roo, Mexico. Having hunted fossils in Florida on two previous trips, we were excited to learn that the same primeval ocean that laid down the limestone making up much of Florida's land mass also produced the limestone and fossil coral reefs that form most of the Yucatan Peninsula. In other words, it is a fossil hunter's paradise.

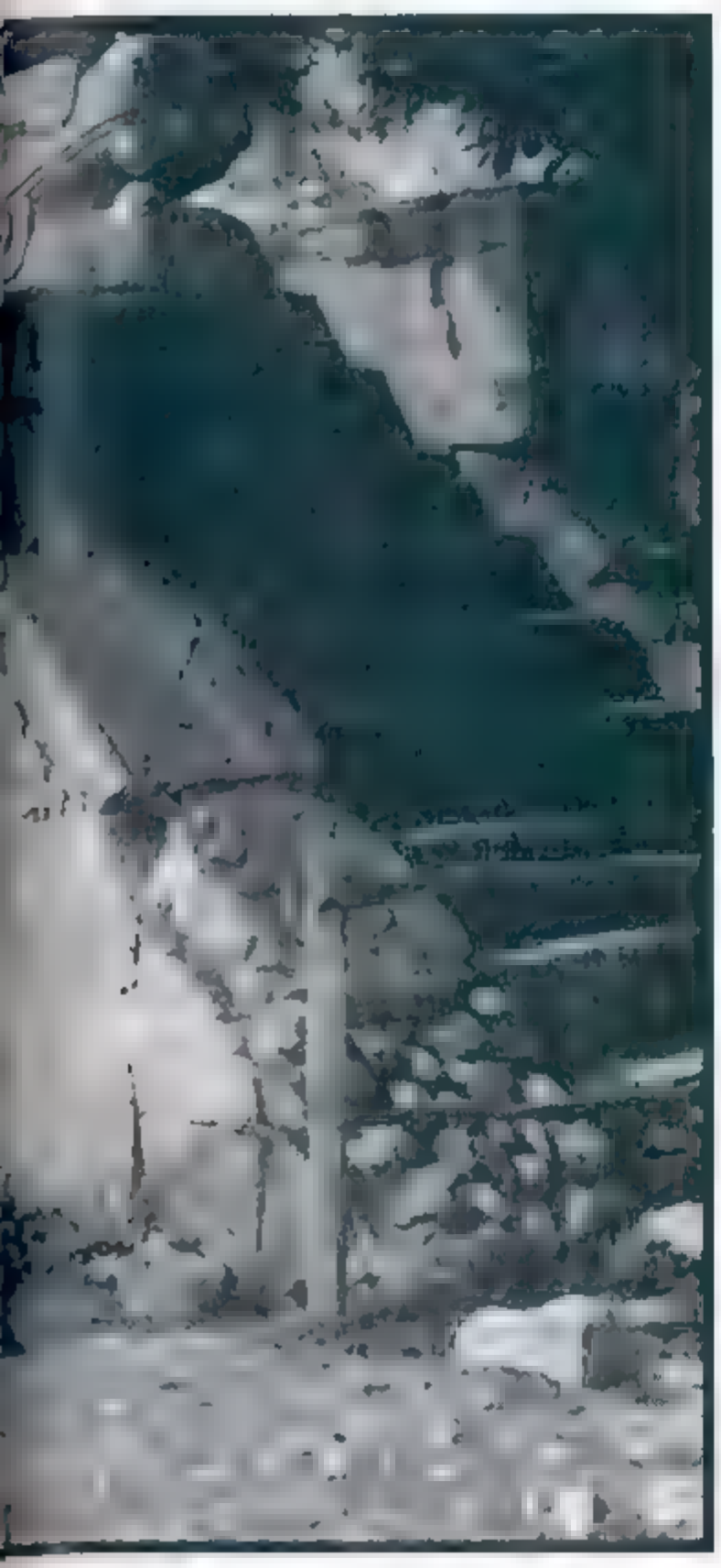
As soon as we were settled into our room, we donned swimsuits, snorkels, masks, and fins and headed for the beach in front of our hotel. Much to our delight, we discovered piles of limestone blocks full of fossil coral strewn across the ocean floor. I was in heaven! We were soon toting bags of rocks back to our room.

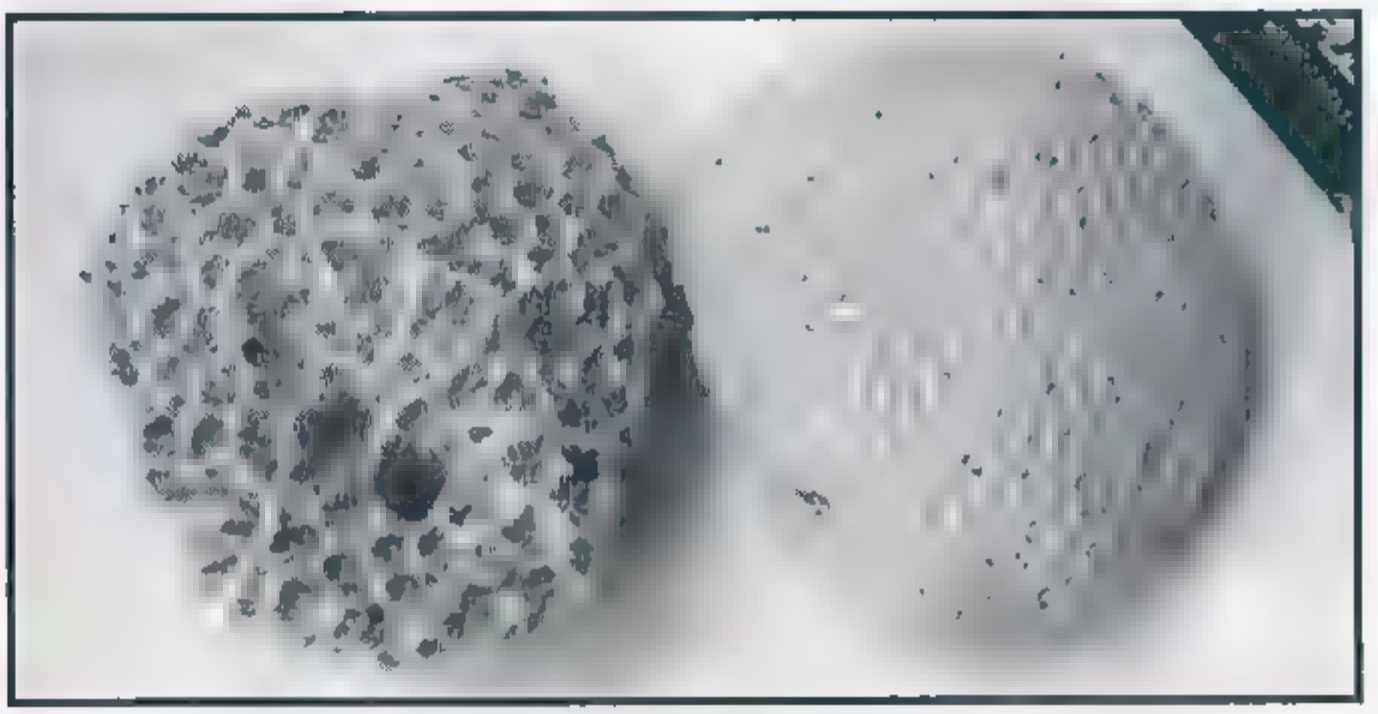
Our first day trip was to Chichen Itza (jokingly referred to as "Chicken Pizza" by the locals). Chichen Itza lies about 150 miles inland from Cancún and is the most famous of the Mayan cities. Dominated by the pyramid El Castillo, Chichen Itza once had a population of about 100,000, but was mysteriously abandoned about 1200 A.D. We noticed there were fossil snails and coral along the path leading from the Visitors Center to the ruins. We picked up a few nice pieces and photographed many others. (Our guide, Umberto, said it was OK to collect a few fossils as long as we did not pick up artifacts.) The temples, pyramid, ball court, and observatory were constructed from limestone blocks, so there were lots of fossils to be admired and photographed.

Perched on a cliff overlooking the turquoise waters of the Caribbean, the ancient seaport of Tulum, our second day-trip destination, is the most beautiful of the Mayan ruins and was still flourishing when the Spanish Conquistadors arrived. Its most striking feature is a building known as The Castle. Among the limestone and fossil debris along the road to Tulum, I picked up a chunk I recognized as being a marine snail. When I got it home and freed it from the matrix, I discovered it was a perfect fossilized conch shell.

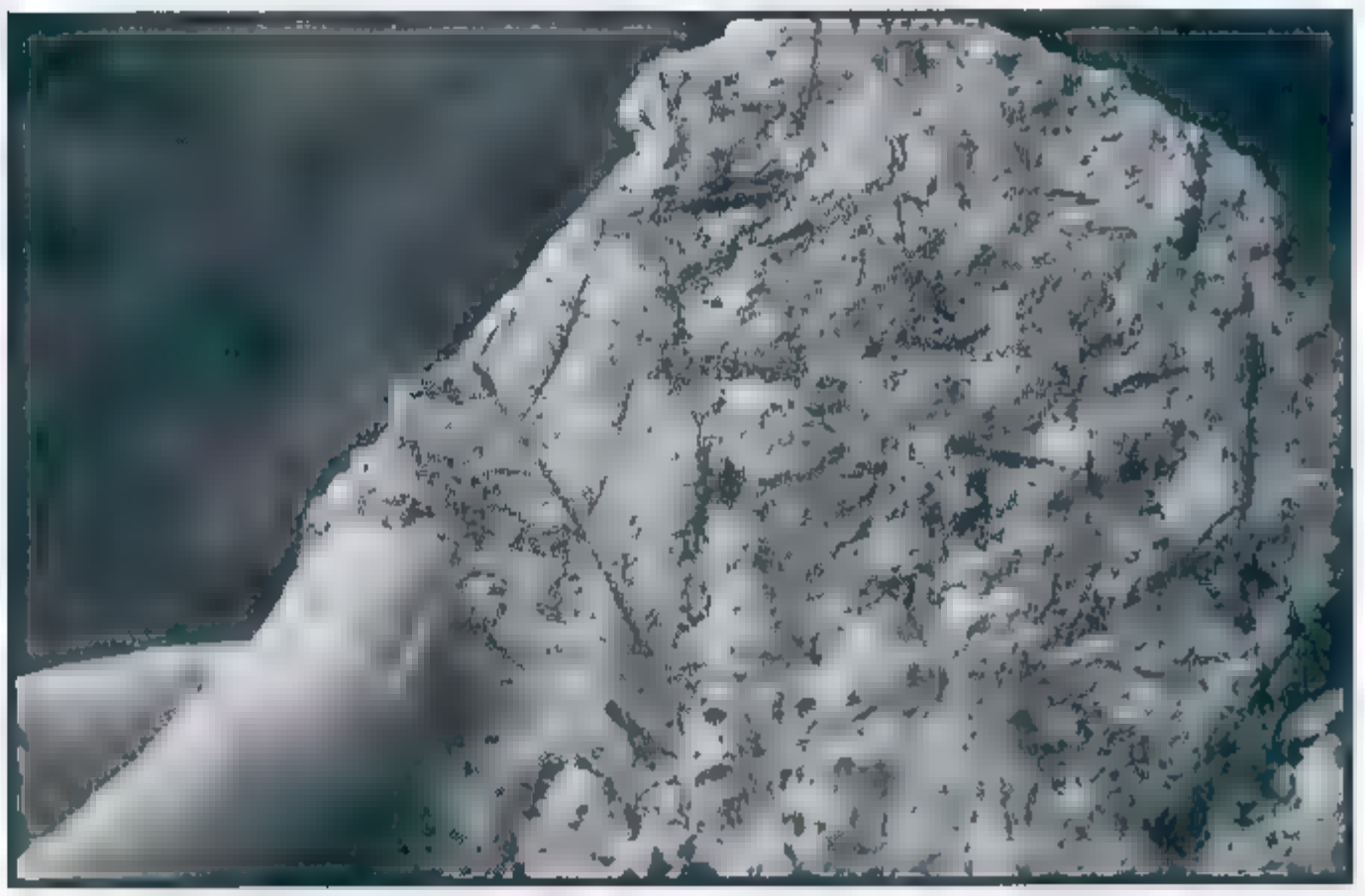
Because the Yucatan Peninsula is comprised mostly of porous limestone, the streams run underground and there are numerous sinkholes and natural wells, which supplied fresh water to the ancient

THE YUCATÁN





We found fossil corals while diving in the water in front of our hotel in Cancún.



While hiking a jungle trail, we observed and photographed several fossil leaves.

cities. There are underground rivers in the two water parks we visited

Located south of Cancún on the Maya Riviera, Xel-Ha (pronounced shell ha) was the first water park we explored. Over 1,000 years ago, Xel-Ha was a safe harbor and port of call for the Mayan merchant marine. Today, it is a huge recreational area encompassing protected lagoons swarming with colorful fish, jungle paths, a crystal river, secluded coves, beaches, and numerous restaurants, while preserving the natural beauty. Like many park visitors, Carole and I slipped into the clear, warm waters of the river where it emerges from its limestone cavern and swam and drifted with the gentle current to the lagoon.

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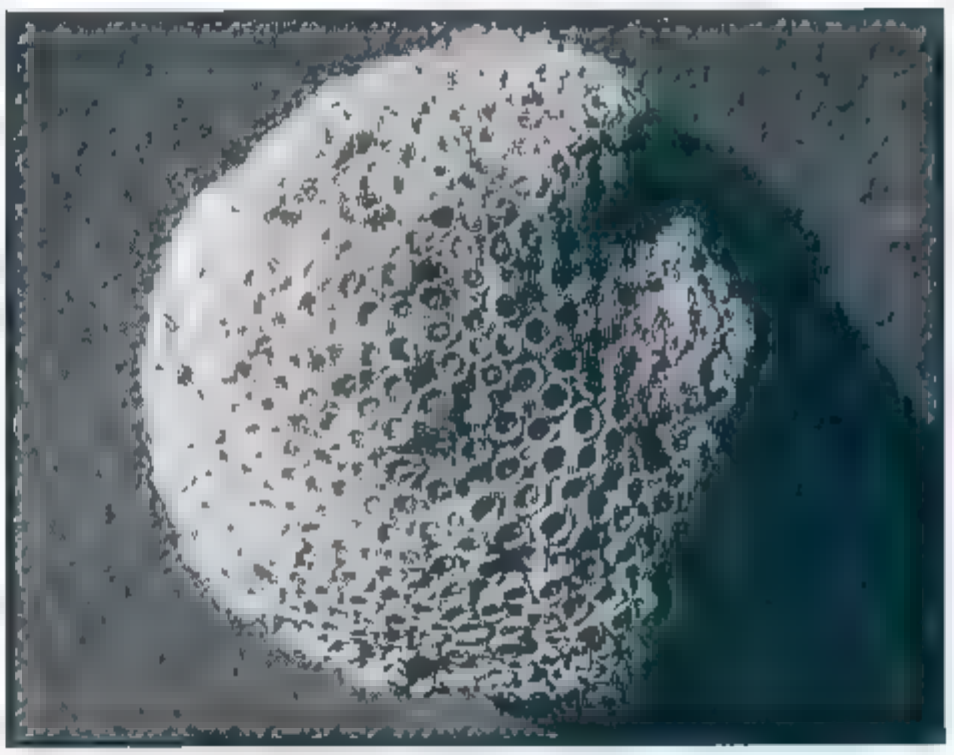


Xel-Ha is a huge recreational area encompassing protected lagoons jungle paths, a crystal river, secluded coves, beaches, and marine fossils.

Fossils in the Yucatán *from page 67*

Our guide said it was OK to collect a few fossils as long as we did not pick up artifacts.

Exquisite examples of marine fossils, mostly snails and a variety of corals, littered the riverbed and lined the open channels leading to the lagoon. Luckily we brought an underwater camera. After our swim and a delicious lunch, we walked a pathway paved with fossilized brain coral to the open ocean. A fossilized reef stretched as far as the eye could see.

Xcaret, also on the Maya Riviera, is an ecological park where brightly-plumed parrots and macaws, flamingos, jaguars, pumas, sea turtles, crocodiles, tropical fish, dolphins, and other indigenous creatures can be seen in their natural habitat. At Xcaret, we swam for a half-mile in an underground river through a maze of well-lit limestone caverns punctuated by open areas. Thousands of fossils are embedded in the walls and ceilings of the caves. Again, our underwater camera came in handy. Later, while strolling through the living history Mayan village within the park, we noticed a pile of fossilized conch shells much like the one I found near Tulum. It would be interesting to know what the ancient Maya thought about fossils.

On our last and most adventurous guided excursion, we visited the Mayan city of Coba. First we had an interesting, and sometimes hair-raising, two-hour van ride courtesy of our guide, Gonzo, through several primitive Mayan villages. We disembarked at a lake which we crossed in kayaks. While hiking a jungle trail from the lake to the entrance of a limestone cave, we observed and photographed several fossil leaves. We descended into the cave backwards, gripping makeshift rope railings while carefully feeling for the hand-hewn steps cut into the rock face.

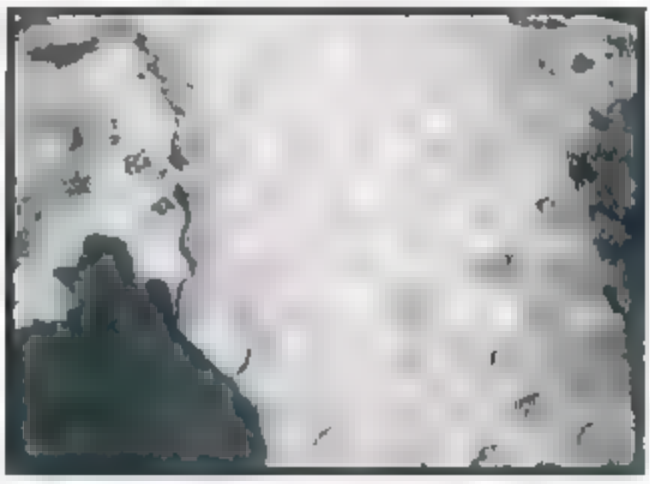
At the bottom, flickering candles partially encircled a shimmering cobalt lake considered sacred by the ancient Mayas. Gonzo invited everyone to take a swim, assuring us it would keep us young. Carole and I quickly plunged into the surprisingly warm water. Much to our delight, the ceiling and walls of the cave contained many beautiful fossils. After our swim we scrambled out of the cave and were blessed by a Mayan shaman.

Another walk along a jungle path led us to our waiting van. We were whisked to a location where (after some brief instruction) we flew across the jungle canopy on a zip line, rappelled down a 100-foot-high cliff, and at last enjoyed a delicious lunch served under palm-thatched shelters (which protected us from the steady downpour) by gracious Mayan ladies.

After lunch, it was on to Coba, where we rode mountain bikes two and a half miles to explore the ruins. Rising above the trees, the pyramid at Coba is the highest in the Yucatan. The city flourished around 600 A.D. Our Mayan guide pointed out several other limestone ruins, as well as an expertly engineered, 1,000-year-old highway stretching 60 miles straight as an arrow from Coba to Chichen Itza. The road is as wide as a modern freeway and was paved in limestone so it would gleam in the moonlight.

Reluctantly, after a week's stay we left Cancun to return to the world of jobs and bills, but not without our souvenirs. Wrapped in newspaper, several of the nicest fossils we had found were tucked into our carry-on luggage which Mexican authorities searched at the airport without comment.

Oh, yes, besides strolling the white sand beaches, we spent an afternoon diving on the coral reef, enjoyed a lobster dinner aboard a pirate ship, listened to music at several night spots, shopped in the marketplace, ate some fine food, and thoroughly enjoyed ourselves. But for me, the most satisfying part of the trip was finding some exquisite fossils.



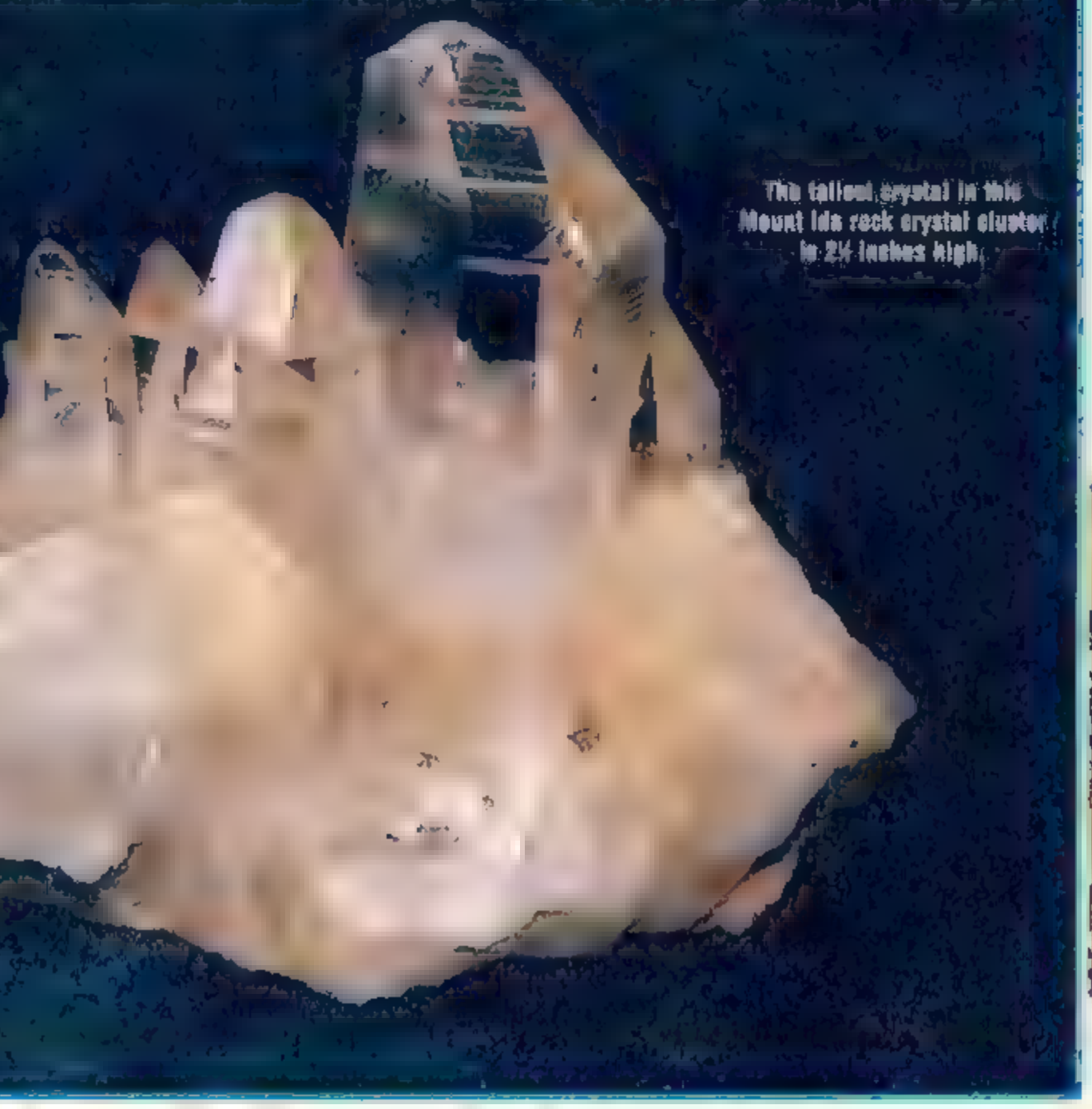
A pathway made entirely of fossil brain coral leads to a fossilized coral reef in the Xel-Ha water park.

FIELD TRIP

MOUNT IDA QUARTZ

Collecting in Arkansas' Quartz Capital

Story and Photos by Kenneth H. Rohn



The tallest crystal in this Mount Ida rock crystal cluster is 24 inches high.

It was late afternoon when I left Coleman's Miller Mountain Mine near Jessieville, Arkansas. My next adventure would be at Mount Ida, Arkansas, some 45 miles southwest of Jessieville via state Route 298 and state Route 27. Mount Ida calls itself the Quartz Capital of the United States, and with good reason. There are numerous mines in the area to back up that statement.

The sun was beginning to set behind Blakley Mountain as I arrived at Lake Ouachita. I was about to spend some quality time at Big Fir Corps of Engineers Recreation Area north of Mount Ida. To reach this campground, drive 4.7 miles north of Mount Ida on state Route 27, then six miles east on state Route 188 to Housey Point Road. It's four more miles (southeast) to the campground, three miles of which are well-maintained gravel. The last mile into the recreation area is paved.

Strangely enough, you won't see a sign pointing the way to the recreation area at the junction of state Route 188 and Housely Point Road. This makes it all the more secluded. If you intend to camp there, it's advisable to check your odometer carefully upon entering state Route 188. At exactly six miles, you'll see the gravel road going off to the right; it's the only road in the immediate area that goes in that direction. This is the road to Big Fir. If you go about a mile past the turnoff by mistake, you'll come to a small community. You've gone too far.

Big Fir is not a campground for large vehicles. It has a limit of 20 feet in length. I was stretching that length a bit with my rig, but the site I chose was plenty spacious. The recreation area is open year-round. There are 17 RV/tent sites to choose from with a 14-day limit. You'll find tables, toilets, fire rings, drinking water (only during warm months), a swimming area, fishing, and a boat launch. The Arkansas Adventure guidebook says of Lake Ouachita, "Unsurpassed beauty, excellent fishing, water sports of all kinds and a prolific area for rockhounds are just a few of the natural attractions of the area."

It was Saturday afternoon when I arrived at Big Fir. My intention was to visit the Stanley Mine in the Mount Ida area, and I'd have to wait until Monday morning in order to spend the whole day in the mine. Sunday hours, as of this writing, are 1 p.m. to 5 p.m.

My time was well spent here. I had a chance to unwind and relax after the long trip from my home up north. I did a bit of research, explored the surrounding forest and lakeshore, studied flora and fauna, took invigorating walks in the brisk mountain air, and enjoyed the weekend.

I learned that in both Garland and Montgomery counties, quartz crystals outcrop on almost every mountain peak. There are an estimated two dozen mines located in the vicinity of Jessieville in Garland County alone. Montgomery County is similarly populated. As would be expected, most of these are private concerns, and as far as I know, the public is not allowed access. There are however, several mines in both counties that do allow fee mining. As an example, while I was driving over to Mount Ida, I saw a sign in the town of Story on state Route 27 that read, "Dig Your Own Crystals." It would be interesting to investigate mines like this.

Only the best quality crystalline quartz is used for jewelry. As would be expected, a good deal of the material finds its way into the scientific and manufacturing industries. There are also a great number of uses for this mineral in electronics. When pressure is applied to thin wafers, a piezoelectrical spark or charge is created. This is useful for igniters in gas stoves and furnaces. There are also many uses for rock crystals in optics and in the making of glass.

During one of my walks while at Big Fir, I noticed numerous snow-white rocks scattered about in the forest some distance from the campground road right of way. Here and there in the road cuts, I also discovered the same type of rocks. They were broken-off chunks of quartz veins. I walked back in a way and discovered more stones scattered all about under the pines. These chunks of milky quartz were undisturbed by man, as near as I could tell, and had actually come to the surface due to the forces of nature. Most of these stones were partially covered by pine needles. Others rested among the roots of trees, with only a tip showing.

I picked one up and saw a pretty cluster of stubby, milky quartz crystals on one side of it. When I examined more of these stones, I found some that had a few clear crystals in the voids. One large chunk that looked interesting was buried with only the face showing. I had to pry it loose with my (big) pocketknife in order to have a better look. It was as big as a football. By this time, I was probably 100 yards in from the road, and I knew that no one had put these stones here. They were simply the natural result of erosion. When I finished examining each stone, I placed it back where I found it for others to enjoy.

The forest here is composed of some very old, large southern pines. I saw several oaks mingling in with the pines. I also discovered hickory trees, with empty nut shells scattered about. The squirrels had made quick work of them. I saw other hardwoods that I couldn't identify. Some of these trees are foreign to me, as they don't grow in northern Minnesota.

The rock formations along the shoreline of Lake Ouachita are most interesting. I took photos of veins of white quartz, some better than a foot wide, exposed amidst colorful bands of sandstone and limestone. All of the quartz here is milky. I found no clear areas in those veins.

I spent two comfortable nights at Big Fir. It grew a bit cool in the evenings with the wind off the lake, but the furnace kept my camper warm. Before retiring, I stepped outside and looked up at myriad brilliant stars. There were no city lights to dim them. As I admired the heavens, I heard a pack of coyotes yelping and howling their lament to the world from a distant shore of the lake.

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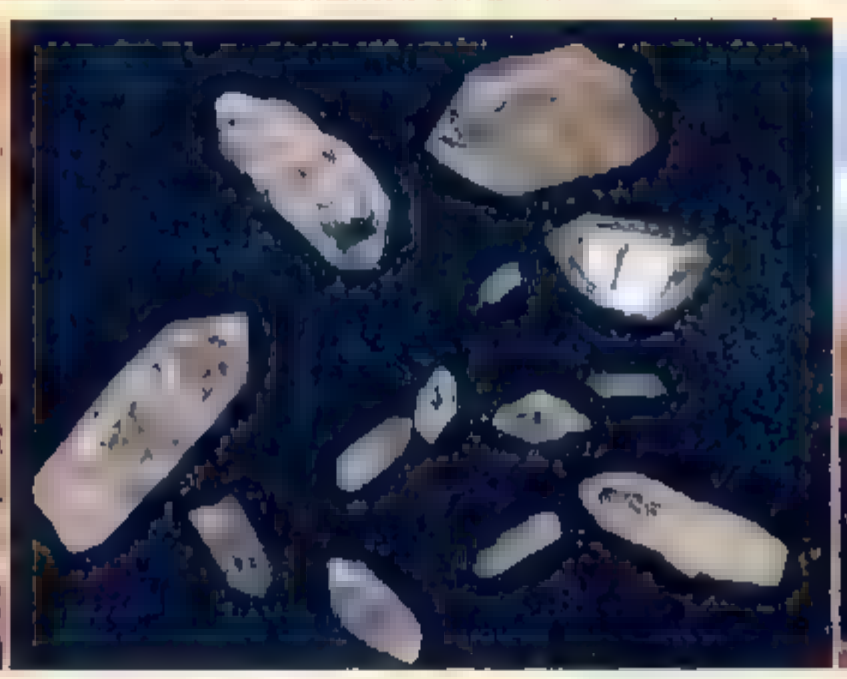
Quartz rock crystals lay scattered about on the surface in many places at the Fisher Mountain Mine.



Most of these water-clear quartz specimens are flawless and could be cut into top-quality gemstones.

This is a good example of citrine crystals that can be collected at the Stanley Mine near Mount Ida.

Later, as I drifted off to sleep, I heard them again. They seemed much closer.

Monday morning, after a hearty breakfast, I drove into Mount Ida to Judy's Rock Shop. This is the headquarters of Sonny Stanley's Fisher Mountain Mine, also known as Ocus Stanley & Son. The shop is situated on Pine Street off U.S. Highway 270. As you drive a few miles northwest out of Mount Ida on U.S. Highway 270, you'll see the sign for the mine on the right at the Pine Street intersection.

The people at the rock shop will sign you in, give you the key to the gate, and directions to the mine. I paid $10 for the day. You can keep whatever you find and do pretty much as you please at the mine. There are two miles of paved road (Pine Street) and a short stretch of gravel before you reach the entrance road. I was told to look for the first road to the right after reaching the stretch of gravel. After inquiring about road conditions and what to expect at the mine, I was off to another adventure.

I found the mine road without any trouble. The heavy iron gate is just off the right of way. I was told to lock it behind me going in and out. I soon became aware of the steep incline ahead of me. Of course, after my experience at the Miller Mountain Mine, this was no surprise. The Fisher Mountain mine is also at the top of a mountain peak. I was told at the rock shop that I shouldn't have any trouble negotiating the entrance road.

When I think of mountains, I visualize steep, rocky crags, covered with snow. The Ouachitas don't quite fit that category, but they are rugged, and they can and do challenge your driving skills. The highest point in Arkansas is Magazine Mountain at 2,753 feet above sea level. That doesn't seem high by Rocky Mountain or Sierra standards, but when you climb steadily up a steep grade for a couple of miles, it seems much higher.

I didn't bother to check my odometer before the climb, so I really don't know how far it is into the parking area at the mine. At a reduced speed, the drive always seems much longer than it actually is.

One thing I soon learned about Arkansas mountains is that it can get mighty windy at the summit. I didn't notice the wind while driving through the dense pine forest leading up to the mine, but once I reached the summit, I was confronted with a very brisk wind out of the northwest.

The view from my high vantage point was spectacular. I was higher than all the other peaks within my sight and I could see for miles in every direction. I looked off to the west and saw another mine pit, the heavy equipment parked to one side amongst the trees. It reminded me of a child's sandbox from that great distance. The trucks and payloaders looked like toys. I couldn't see any sign of activity.

There was nothing to stop the wind that morning at the mountaintop, and I assumed correctly that a storm was on the way. This was a cold front moving quickly into the area. When I parked, I backed into the parking place, right into the wind. I had a very difficult time with my camper door. It acted just like a sail and whipped violently out of my hands a couple of times, before I was able to subdue it. I remedied the problem by turning the truck around, with the front facing the wind.

It was around 10:30 a.m. when I entered the mine pit. This mine is quite different from the last one I collected at. We are actually allowed to enter the mine proper and collect there. The mine is not what I expected. A portion of the overburden on the mountainside is carved neatly away, exposing different layers and veins of rock and gravel. Collecting is done right on the mountainside. The exposed area drops at a not-too-steep angle down to a fence at the bottom. Here, the overburden has been deposited, making a narrow, flat area the length of the mine. I'd guess the pit is at least 200 to 300 feet from the top at the parking area to the bottom where the fence is, and perhaps 1,000 feet or longer. Beyond the fence is another far drop to the valley floor. No one is allowed beyond the fence for safety reasons.

Although I saw no equipment, it may have been parked farther along the road behind a gate in the distance. I would assume from my mining experience that the pit was dug and scooped out with a drag line on a very tall boom. It appears too steep for a bulldozer.

As I made my way into the pit, the wind gradually subsided to a slight breeze. The sun was shinning brightly, with hardly a cloud in the deep blue sky. I had put on a jacket before leaving the camper because the wind was cold. But being a northerner, I was used to much colder weather and soon unzipped it. When I looked [illegible] me, probably halfway across the mine pit, I thought I was all alone. No other vehicles were parked in the parking lot. I was mistaken. I soon met another collector at the far end of the pit behind some boulders. I asked him how he was doing, as I hadn't collected anything yet myself. He told me that the mine people had given him a ride and were due to pick him up at around noon. He said he was doing well and had collected a nice selection of crystals. He also told me that he had come to Arkansas many times throughout the years from his home in Missouri, but this was the first time he ever tried collecting rock crystals. He was enjoying himself immensely. I wished him luck and walked toward several sparkling crystals with my name on them.

Many of the crystals that I picked up lying right on the surface are of gem quality and perfectly clear. Most have no blemishes or inclusions in them, they are perfect, natural jewels.

I didn't see the need to dig for the crystals, although I noticed several holes here and there where collectors had done just that. If you'd like to dig, you have a whole mountainside in which to do so. I'm sure some good crystals could be recovered that way. I found no muddy areas at this mine, just coarse orange dirt and rocks.

While searching around some of these holes, I actually discovered an occasional good quality crystal that the diggers had missed. Maybe they had been covered with dirt and were easily overlooked. Wind and rain had done the work for me.

This rock crystal collected in Garland County, Arkansas, has the typical hexagonal, prismatic habit and a complicated pyramidal termination.

I decided to search on a horizontal plane rather than climb up and down the mountainside. This was much easier and I was able to cover more ground in a shorter time. Of course, in an area this large, it's impossible to cover even a small portion of the collecting site in the limited time spent here.

I began my search at the bottom, walking parallel with the fence into the sun. When a glint of sunlight caught my attention, I'd follow it down and carefully inspect the place. Many times during the day, this method proved fruitful and I'd discover a good crystal. Quite naturally, many reflections proved to be badly fractured pieces of crystals, but I checked them out just the same. The milky quartz crystals that I encountered at the mine also reflected with a brilliant glint of light, but I left most of them where they were.

It was around noon when I glanced up to see a vehicle approaching the parking area and the guy from Missouri walking

toward it. He and the driver both waved and went on their way. I now had the entire mine to myself. I began to feel hungry from all of the fresh mountain air plus the vigorous exercise, and climbed up to the camper for a lunch break.

My pouch was beginning to drag at my waist and a few very nice clusters of crystals on matrix were in my jacket pockets. I carried one huge rock up to the camper with numerous stubby clear crystals covering one face. It weighs 10 pounds. The longest crystals are close to [illegible] inch and [illegible] inch in diameter.

When I reached the camper, the wind had subsided a bit, although it was still windy at the top. After a sandwich and a cup of coffee, I made my way down the mountain and resumed my collecting. I didn't have to do much digging. When I did, it was only to loosen up an area around a crystal point that was exposed on the surface. I used my ice pick for that. If you decide to dig for crystals, I'd suggest a screen with no larger than [illegible]-inch mesh. A folding shovel is easy to pack, and it does the job most adequately.

The day went too quickly, and before I realized it, the shadows were getting long on this orange-colored mountainside. I had collected a very fine selection of rock crystals. Many of them are water clear. A few are doubly terminated twins, with a perfect hexagonal habit. I found some faint tean toward [illegible], but they are more washed out and only have a faint hint of yellow. The largest ones I found that day are no more than 2 inches long by [illegible] inch in diameter, but they are excellent. Some of these crystals have strangely different terminations. The points and the crystal bodies themselves are slightly flattened, but this gives them character.

I had a wonderful day at the Stanley Mine, and the sun was beginning to set when I locked the gate behind me and returned the key to the shop.

As mentioned earlier, there are several possible locations for collecting quartz rock crystals in this area. I only visited two. For more information about the Stanley Mine, call (870) 867-3556 (day) or (870) 867-3719 (night), or write to Sonny Stanley, P.O. Box 163, Mount Ida, AR 71957. For information on other fee mines in the Mount Ida area, visit the Web site www.mtidachamber.com/crystal_information.htm or call (870) 867-2723.

Arkansas has a vast number of campgrounds, several state parks, and Hot Springs National Park. Most of these are open year round for our enjoyment. Some campgrounds are even free in the off season. It's a great state with fantastic scenery and excellent rockhound sites. I had a great time in Arkansas, and you can too.

Caldrons of Garnets

Brazil's Navegadora Mine Sees New Spessartine Strike

Story and Photos by Bob Farrar

Those of you who regularly go to rock shows, as I do, know that every so often something new and exciting hits the market. Despite the fact that mineral collecting has gone on for centuries, new and interesting minerals are still being found, as are extraordinary new deposits of familiar minerals.

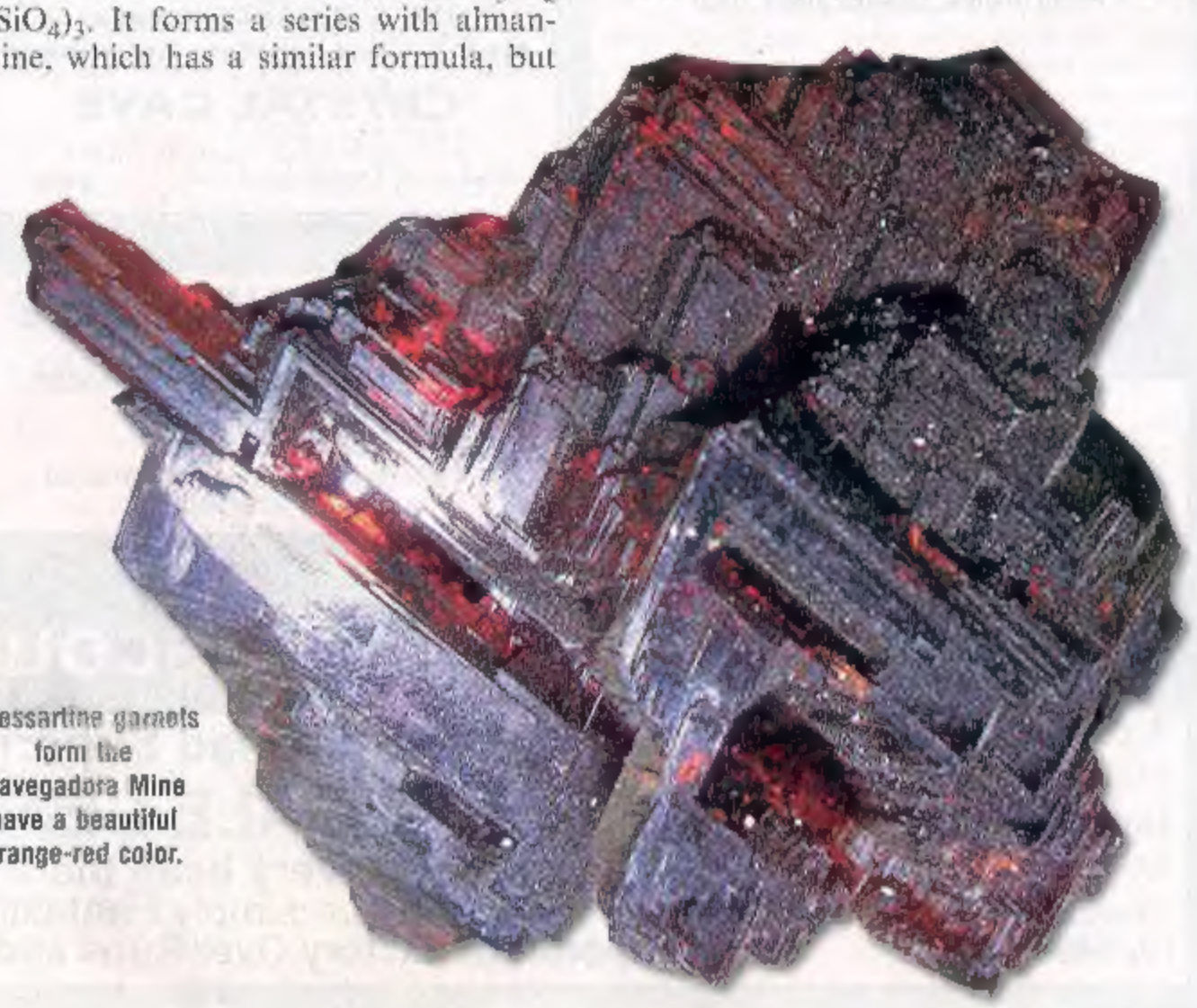
Recently in Brazil, a new strike of spessartine garnets was made. A couple of years ago, beautiful orange-red spessartine crystals began appearing on the market. As is often the case with important new finds, details about the locality were a bit confused, though the general area of the occurrence was known to be Minas Gerais. Recently, though, I was able to visit the mine that is producing these beauties and see for myself exactly where they come from and how they occur.

The locality to which I am referring has been known as Orozimbo, as well as Navegador. Orozimbo, it turns out, is the name of the owner of the land on which the mine is located. The mine itself is actually owned by someone else, Rogerio Zocoloto. He refers to the locality as the Navegadora Mine. Since he should know better than anyone else what the locality should be called, I shall use his name for the mine. It is located in Minas Gerais, about 40 miles southeast of the city of Governador Valadares, and about 10 miles northeast of Conselheiro Pena. The nearest town is the village of Penha do Norte. This region is famous for its pegmatite minerals; fine tourmaline, beryl, spodumene, and many other minerals are found there.

How I came to be able to visit the Navegadora Mine is purely a matter of connections. I know Sara Mount, who has been organizing gem and mineral tours to Brazil since 1988. Sara knows Harold Wallner, who has been her tour guide in Brazil for every trip she has taken. Harold knows Jan "Johnny America" Vlcek, a prominent gem and mineral dealer in Governador Valadares. And Johnny knows Zocoloto, the mine owner. It was through the efforts of all of these people that the visit was arranged.

Garnet is not a mineral species, but a group of silicate minerals. Spessartine is distinguished by the presence of manganese in its chemical formula, $Mn_3Al_2(SiO_4)_3$. It forms a series with almandine, which has a similar formula, but contains iron instead of manganese. In a series such as this, the iron and manganese are interchangeable: crystals with mostly manganese are spessartine; those with mostly iron are almandine. Spessartine is commonly, but not exclusively, found in pegmatites, such as in Amelia, Virginia, San Diego, California, and Brazil.

Spessartine crystalizes in the cubic system, and in some environments, occurs as well-formed trapezohedrons or trisoctahedrons (24-sided polyhedrons.) This crystal form is not seen at the Navegadora Mine, however. There, the spessartines occur as irregular step-grown crystals. They might appear at first to be heavily etched, but they are in



Spessartine garnets form the Navegadora Mine have a beautiful orange-red color.

Mine owner Rogerio Zocoloto points out a small pocket from which spessartines had been recovered.

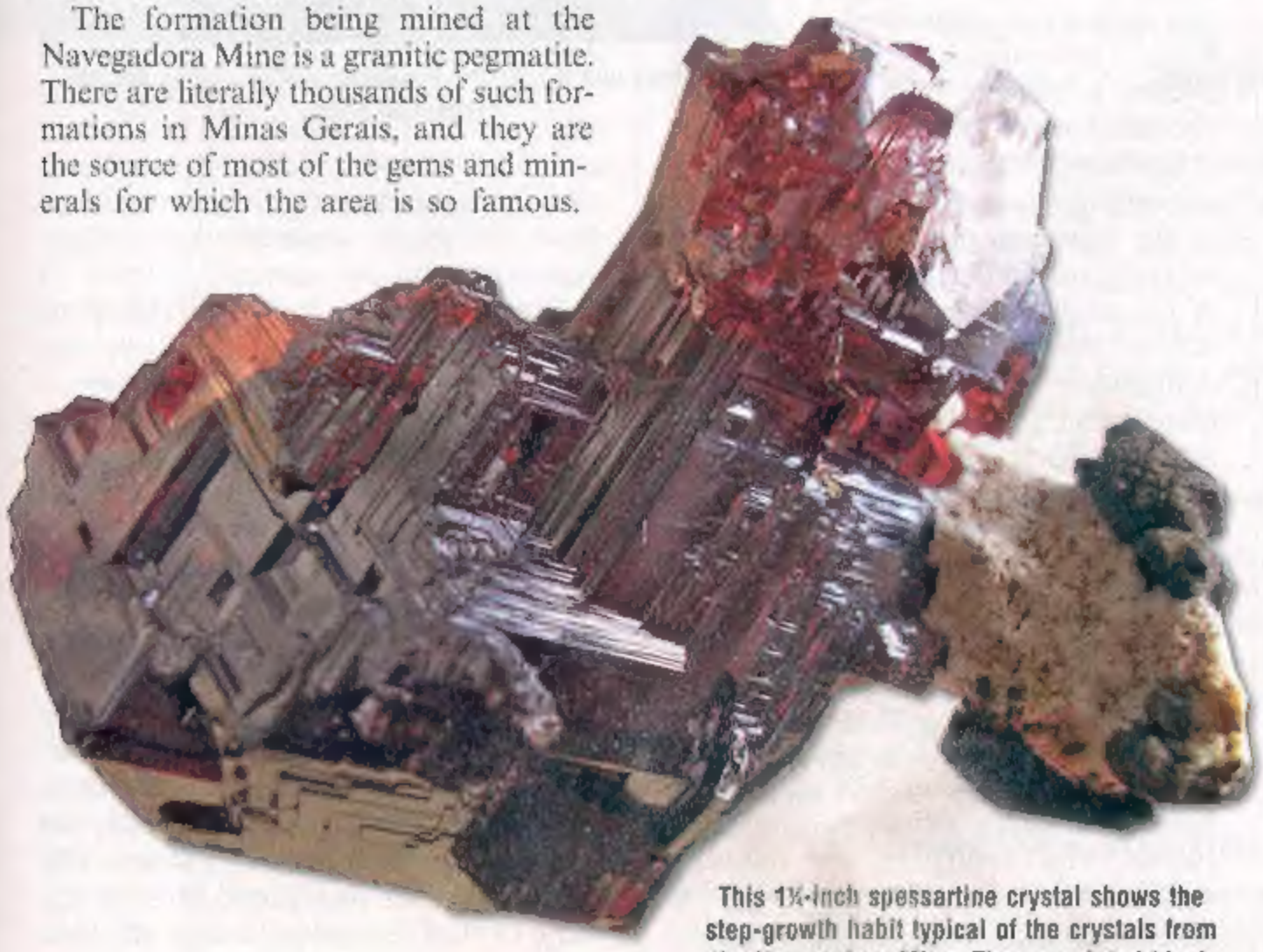
This 5-inch specimen is among the larger spessartines from the Navegadora Mine.

fact cleanly crystallized on all faces. No two crystals are exactly alike; they may be rounded, flattened, elongated, or some combination thereof. They remind me a little of the spessartines from the Rutherford Mine in Amelia. Those that I have seen range in size from microscopic to a monster about 5 inches across. Most are under an inch. Many crystals are internally flawless and would make excellent gem material. However, with all due apologies to any faceters who may be reading this, I think it would be a crime to cut such beautiful crystals. It would be hard to improve upon this example of Mother Nature's handiwork.

The formation being mined at the Navegadora Mine is a granitic pegmatite. There are literally thousands of such formations in Minas Gerais, and they are the source of most of the gems and minerals for which the area is so famous.

The pegmatites of Minas Gerais are thought to have formed some 490 million years ago. At that time, magmas intruded into much older Precambrian metamorphic rocks. The magma did not erupt at the surface from volcanoes; rather, it was trapped some 2 to 3 kilometers below the surface. Being buried so deeply, the magma cooled very slowly, allowing large crystals to grow.

By far the greatest proportion of minerals in a granitic pegmatite consists of quartz, feldspar and mica. As these materials crystallized out, the more volatile materials, such as water, fluorine and chlorine, and rarer elements, such as lithium, boron and beryllium, became more and more concentrated. In the late stages of the pegmatite's formation, hot solutions of water and the rarer elements became concentrated in cavities, where many of the most interesting and valuable minerals crystallized. In these cavities, crystals could grow unimpeded, in many cases forming cleanly terminated, gem-quality crystals. Many of the best tourmalines, beryls, spodumenes, and quartzes were formed this way, as were the spessartines of the Navegadora Mine.



This 1¼-inch spessartine crystal shows the step-growth habit typical of the crystals from the Navegadora Mine. The associated black mineral may be a manganese oxide.

Today, we refer to crystal-containing cavities in a pegmatite as vugs, pockets, or miarolitic cavities. The Brazilians, however, call them "caldeirãoes," or caldrons. Considering that they were once filled with hot solutions, I think caldron is a very apt name for them.

In the 490 million years or so since the pegmatites were formed, a great deal of weathering has occurred, resulting in exposure of the formations at or near the surface. The amount of weathering of the pegmatites varies tremendously. Some are completely weathered away, with their more resistant materials such as beryl and quartz coming to lie in secondary alluvial deposits. The Marambaia area, for example, is famous for aquamarine. Other pegmatites are still in place, but are deeply weathered, with the feldspar having decayed into kaolin. An example of this type of deposit is the Mucaia Mine, where material is washed and screened to recover topaz and beryl. At the Navegadora Mine, little weathering can be seen; any weathered material has probably moved downhill from the site. The pegmatite is solid rock right to the present surface, and hardrock mining techniques must be used to recover the minerals.

continued on next page

The site of the Navegadora Mine was first worked about 100 years ago, when mica was mined from surface pits. At the time of our visit (August 2004), Rogerio had been working it for 13 years. He produces some 200 tons of industrial-grade feldspar per month, which pays the bills—salaries for eight to 10 miners and fuel and explosives expenses. It was only in 2002 that Rogerio hit his first big caldron containing spessartine garnets.

The pockets at the Navegadora Mine are huge. The first one measured about 15 feet by 30 feet; the largest, about 15 feet by 60 feet. The pockets are lined with a layer of cleavelandite (crystalized albite feldspar) several inches thick. It forms rounded masses known as cabeças, or heads. While the cleavelandite appears solid on the surface, its interior is porous. The basal portion of the cleavelandite (toward the outside of the pocket) has numerous cavities. It is in these cavities that the spessartine crystals are found. They may be found loose in these cavities, or attached to the cleavelandite or small quartz crystals. They are recovered by breaking up the cleavelandite. The finer (sand- to gravel-size) material is washed and screened to recover the smaller crystals. One pocket contained five tons of garnet-bearing cleavelandite. Rogerio estimates that his best pocket produced spessartine crystals worth $200,000.

Spessartine is not the only interesting mineral found in the pockets of the Navegadora Mine. On the inner surface (toward the inside of the pocket) of the cleavelandite may be found crystals of helvite. Helvite is a silicate of manganese and beryllium, $Mn_4Be_2(SiO_4)S$. It occurs as dark grayish tetrahedral (four-sided) crystals up to several millimeters across. Crystals of helvite may be found attached to the cleavelandite or loose.

The Navegadora Mine also produces dendritic quartz. This material occurs as translucent to transparent masses ranging from colorless to brownish to yellow. The yellow material does not really look like citrine; it is more of a lemon yellow, perhaps from sulfur. The dendrites are included within the quartz. Dendritic quartz can be faceted into interesting gemstones. Unlike the spessartines, I have no objection to anyone cutting the dendritic quartz.

Large beryl crystals are found at the Navegadora Mine, though the ones I saw were not gem quality. One exposed near the surface was greenish and about 6 inches in diameter. Another from the dumps was pale bluish and about 1½ inches across.

Much of this information was related to us by Rogerio during our visit, as he enthusiastically talked about his mine. Our first stop was at Rogerio's house in Galiléia. He showed us a selection of his finest material, including that monster spessartine about 5 inches across and smaller crystals ranging up to perhaps 2 inches. He also had chunks of cleavelandite that show how the spessartine occurs within the cleavelandite, with the helvite on its surface. A worker in the backyard was washing and screening fine material that had been trucked from the mine, while another cobbed pieces of dendritic quartz.

Dendritic quartz from the Navegadora Mine can be cut into interesting gems.

From Galiléia, it was perhaps an hour's ride to the mine. The drive was exciting for me, as I knew we were traveling through one of the most famous pegmatite areas of Brazil. Just to look at the countryside as we passed through, however, one would have little clue as to what has come out of there. You don't see a lot of evidence of mining along the road. Most of the pegmatite deposits are small, relative to the total land area, and are not really apparent until you get close to them. The Navegadora Mine, for example, only covers a few acres. You mostly see small farms and cattle ranches. The road is a good, paved road most of the way; the last few miles, though, are dirt.

The mine itself is located on the side of a hill. It is reachable via a narrow dirt track extending maybe a mile from the road. The weather had been dry, so the trail was not too difficult to climb. Had it been raining, it might have been another story. Sara usually schedules her trips during the dry season (May to October) for this reason, as well as because the temperature is more pleasant, usually in the 70's or 80's. Our only obstacle in reaching the mine was some cows in the road that did not want to move. Once there, we had a beautiful view of the Itatiaia Mountains, also a famous mineral locality.

The Navegadora Mine is primarily an underground mine, with a small surface pit adjoining it. Eventually, the surface pit will connect up with the tunnels. Exposures in the surface pit are primarily of the usual pegmatite minerals, quartz, feldspar and mica. Though the large beryl crystal was exposed here, most of the spessartines are found in the underground portion of the mine. The tunnels extend some 200 yards, generally horizontally, into the side of the hill. A room-and-pillar mining system is used, in which columns of rock are left in place to support the roof. The tunnels are quite large, with the roof perhaps 40 or 50 feet high. The entrance to the mine is quite a bit smaller, just big enough to park a truck in to close it. Branches of the tunnel extend to the sides. Much hand labor is involved in mining at the Navegadora Mine, though power tools such as drills are used and electric lights illuminate the working areas.

Rogerio was between pockets at the time of our visit. The last one had largely been cleaned out, though remnants of pockets could still be seen. In some, large smoky quartz crystals were visible. Parts of the cleavelandite layer were also still there. In one spot, the miners pried up some of the cleavelandite and pulled out a few small spessartines, and there were helvite crystals in another place. Bits of dendritic quartz were lying about.

Rogerio was expecting to hit more pockets soon. He stuck a pick handle into one emptied pocket and banged it against the back wall. It made a hollow sound. Given the recent history of the Navegadora Mine, and Rogerio's experience as a mine operator, I expect that it will only be a matter of time before the next big caldron of beautiful spessartine will be found. I only wish I could be there to see it.

BRAD L. CROSS PHOTO

After dry sanding, Brazilian agates are polished on hard felt wheels with cerium oxide.

"recipes" are rarely shared. Many of the chemicals employed in agate coloring are toxic and corrosive. The dyeing vats were the only areas I saw where protective clothing and masks were being utilized. The higher-quality colorful agates are rarely dyed or heat treated. Not only does the color not need to be enhanced, but the high-quality agates do not take acid dyes or heat treatments as well as the low-grade blue-gray agates.

COMMERCIAL AGATE CUTTING

My visits to the cutting factories in Soledade and Lajeado were awe inspiring. The cutting factories vary in size from small operations with only one or two family members cutting and polishing agates within their homes to larger operations with 20 or 30 people cutting and polishing agate in three or four different buildings.

At the larger factories, the sales rooms contained table after table of cut and polished agate containing sharp bands, broken veils of color, and the occasional perfect bull's-eye. There were thousands upon thousands of polished slabs, hundreds of sets of bookends, and stacks of agate ashtrays. One 4-foot by 8-foot table may contain only natural colored agate. Others may be designated for only agates that were dyed blue, while another table holds only purple agates. In the corner of the room were several 55-gallon drums full of cut and polished enhydros, agates containing water. Many of these specimens are cut too close to the hollow pocket, and the water is eventually lost; the polished pieces are stored in water to assure the water does not evaporate prior to sale.

As you walk out of the showroom, you enter an area where tens of diamond saws of various blade sizes are lined up. Piles of agate are sitting on the floor next to each saw, waiting their turn to be cut. After being cut into slabs or bookends, the agates are scrubbed in a soapy water solution, then immediately transferred to the sanding room. Here, dozens of horizontal high-speed sanding machines are used to quickly sand the specimen, preparing it for polishing. Although the results are excellent, dry sanding causes extremely unhealthy working conditions. The air is thick with agate and silicon carbide dust, and one has to wonder about the unmasked cutters' life spans. After a quick washing, the agates are polished on large hard felt wheels using cerium oxide imported from the United States. The stones are washed and priced based upon the number of square centimeters polished, and packed into drums of coarse sawdust for shipment to world-wide destinations.

Polished slabs are an interesting phenomenon. Slabs of ¼-inch thickness or less are held by hand and dry sanded on the large, horizontal, high-speed sanders. First one side of the slab is sanded, then the other, without any washing between the 220- and 600-grit sizes. The cutters are good at what they do; they have to be or they wouldn't have any fingers left. The slabs are finally rinsed and then polished with felt. Cutting is the most time-consuming component of the process; sanding and polishing both sides of the slab only takes about 10 minutes for a 3-inch piece.

AGATE GEODES

A large number of agates from Rio Grande do Sul are hollow and can't be processed into slabs, bookends or ashtrays. These specimens are indeed geodes, informally called agate "pots" by collectors, since the bottom portion is somewhat reminiscent of a planting container. These agate geodes usually have a thick, banded agate rim (from ½ inch up to several inches or more) enclosing a hollow center of drusy quartz crystals. Minute rust-red to black secondary iron and manganese minerals are many times found delicately perched on the surfaces of the drusy quartz.

These hollow agates are singled out from all the other material mined by a process known as hefting. It's easy to determine relative density of hollowness by comparing two agates of about the same diameter. An agate is placed in each hand and raised and lowered to compare the relative weight. Those that are determined to be geodes are set aside and will receive special lapidary treatment. Most of these agate geodes have a somewhat flat base and a slightly domed top. The upper third of the geode is cut to reveal its inner sparkling beauty. Both pieces are then sanded and polished, and ultimately sold as a pair.

It's important to note that the fabulous amethyst tunnels or geodes commonly seen at rock shows today are not found in association with the agate deposits. They are separate and distinct occurrences found some 30 miles north and west of the agate deposits. I will address these colorful gems in another article.

"OCOS"

An article on Brazil's agate country wouldn't be complete without a mention of the "Ocos." The Oco geodes are found in the Tres Pinheiros (Three Pines) region, some 80 miles northeast of the cutting center of Soledade. While many names have been given to different varieties of geodes found throughout the world, none of these names are perhaps as appropriate as Oco, Portugese for "hollow."

Ocos range in size from 1 inch to 5 or 6 inches in diameter. The average geode is comparable in size to a tennis ball and is often prune-shaped. The skin on these gems is extremely thin, rarely over ¼ inch thick. Clear drusy quartz lines the interior and is found coating a backdrop of tan, brown, gray, or black. Its brilliant sparkle is reminiscent of diamonds the size of granulated sugar. Many of the Ocos contain black, needlelike secondary inclusions that are most likely goethite.

Most of the Ocos contain water and are therefore enhydros. However, few specimens are preserved as such. Cut in half, polished, and offered in pairs, these geodes make striking decorative items and are affordably priced. These geodes are easily distinguished by their white and clear ropelike chalcedony shells. The rims display prominent white wavy or flamelike patterns similar to the desert roses of the Southwestern United States. Chalcedony displaying this flowing white pattern is known to European collectors as "cloud agate," although the name has not been adapted by U.S. hobbyists.

"Poverty stricken" only begins to describe the rest of the world's agate deposits when compared to those of Brazil. Never have I been so amazed as when I drove across a streambed and found half the rocks in the bed and banks were agates. The incredible abundance of agate in the streambeds spoke volumes about how much agate must be contained in the surrounding hills. My value system suddenly disappeared, and I was forced to create a better frame of reference and a new standard of excellence.

Brad Cross is author of The Agates of Northern Mexico *and* Gem Trails of Texas. *His new book,* Geodes: Nature's Treasures, *coauthored with June Culp Zeitner, will be available in late 2005.*